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Science Education

The Science Magazine for All Science Teachers

Formerly General Science Quarterly

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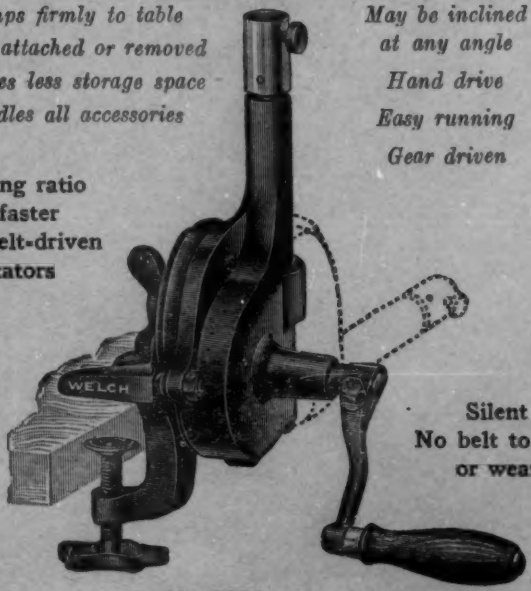

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SCIENCE EDUCATION

Devoted to the Teaching of Science in Elementary Schools, Junior and Senior High Schools, Colleges and Teacher Training Institutions

(Formerly GENERAL SCIENCE QUARTERLY)

Vol. XV NOVEMBER, 1930 No. 1

The Training of Science Teachers for Secondary Schools[1]

HANOR A. WEBB

Professor of the Teaching of Chemistry, George Peabody College for Teachers

Professor N. Henry Black, a prophet with considerable honor in his own country as well as in the outlands, has recently made this comment[2] in the light of his observations:

"When all is said and done, I suspect that we Americans, by and large, do not really believe that any special training is necessary for a science teacher. We still naively believe that a mature man or woman ought to be able to do a tolerable job [of science teaching] by keeping at least one week ahead of the class. Of course, we who are here realize that this is quite inadequate and that the results of such a procedure are quite disastrous."

Yes, we who are here agree with him fully, both as to his interpretation of existing conditions and the misfortunes that attend them. Science teaching is in an unbelievably chaotic state, not only in the less progressive regions, but also in many of those that have had organized systems for years. I could refer you to study after study in which the obvious facts have been worked out on quantitative bases.[3] Anywhere from two to four different subjects is commonplace, six or more are not unusual as a load for the high school science teacher.

1 Excerpts from an address at the dedication of the new building, School of Education, New York University, New York City, Science Education Conference, March 1, 1930.

2 N. Henry Black, "The Training of Science Teachers, Here and Abroad," in School Science and Mathematics, XXX, 153-160 (February, 1930).

3 Fourteen such studies are listed by Jesse M. Shaver, "The Training of Teachers of Science for Junior and Senior High Schools," in Nature and Science Education Review, II, 69-74 (January, 1930).

Such conditions should not guide to any marked degree the courses planned for training teachers. Curricula should never acquiesce in genuinely burdensome teaching programs. Some of these offences against good educational policies will cure themselves in time; in a sense we are more sorry for the children who must endure such teaching than for the teachers who are oppressed. The child, at least, is the innocent party; the teacher at times is *particeps criminis* in the arrangement by which a Latin and English specialist agrees to take a class in general science in an otherwise idle period.

You will not discover in this discussion, however, any recommendation that may be construed as of the other extreme. We are not particularly enthusiastic concerning the training of science specialists for high school teaching. There are two reasons against the one-subject science teacher as a class, no matter how excellent he may be as an individual: first, only one high school out of a thousand can use his services for a single subject, and second, even though teaching in but one field, he has no right to fail to keep up with the progress of other sciences, and to miss the inspiration—both for himself and his pupils—that comes from achievement today in biology, tomorrow in chemistry, the next day in physics, again in astronomy, repeatedly in combinations of several sciences in a great invention, and eternally in the contribution of every field of knowledge to the onward march of civilization. Really, the story by O. Henry of the down-and-outer who tried to get himself locked up in a cell has its counterpart in that science teacher who is at the same time mentally lazy—and a specialist!

The only objection to multi-subject combinations, in my judgment, should be to those that are obviously incongruous—as one or more sciences with Latin, French, history, and the like. There is one large combination which we should accept as desirable both in theory and in fact: this is that list of sciences that is regularly taught in high schools—general science, biology, physics, chemistry. There are three other subjects which we may expect to be very frequent members of the party; these are, mathematics, agriculture, and home economics. We have pride and congratulation for that teacher who has prepared to teach all of the first group, and any one of the second. He is no object of sympathy; he is well on the way to becoming a real scientist.

Mathematics has a claim for membership in this group of teaching combinations on two accounts; first, its services as a foundation for real accuracy in each of the other sciences, and second, its presence as a teaching combination with science in greater frequency—as shown by studies in all parts of the country—than any non-science high school field. We do not pity a teacher who carries a reasonable load of science and mathematics; it is an approved program.

Agriculture and home economics have their foundations upon the bed-rocks of biology, physics and chemistry, no matter to what degree the actual teachers of these two applied subjects have been satisfied to build their houses upon sand. In planning any curriculum for the training of high school science teachers, the needs of these two fields must be considered jointly with the offerings for other science teachers. There are countless situations where the teacher of agriculture must be responsible for one, two, or all the other science courses, or where the lady in the school kitchen must also assume responsibility for one or more of the school's laboratories. There are many teachers colleges, however, where there is little co-operation between the instructors of the three formal sciences (biology, physics, chemistry) and the two applications thereof (agriculture, home economics). Each goes his own way, as if the others never existed.

There are, then, seven subjects for which we must prepare high school science teachers: three fundamental—biology, physics, chemistry; two applied—agriculture, home economics; one accessory, both before and after the fact—mathematics; one—general science—which stands somewhat in the relation of a guest, having come but recently, and now showing signs of moving down into the junior high school or even lower for permanent residence. As long as this subject is with us as a high school course, however, we must serve its needs and train its teachers .

The obvious need for width, with reasonable depth, of training for high school science teachers has not been met by the typical teacher-training institution for one principal reason—the crowded curriculum. It is a commonplace assertion among students of these institutions that the burden of courses on *how to teach* is so great that adequate preparation in *what to teach* is impossible. It is a rare student who can get two

courses in science in each of four years under present conditions. Scholastic requirements of one major and one or two minors often absolutely block a person who—as a prospective teacher of home economics, for example—could not possibly take even an elementary course in each of the foundations of her specialty—biology, physics, chemistry. Her brother student, seeking training to fit himself as a straight science and mathematics teacher, would run aground on the shoals of specific catalog requirements before he could secure the reasonable minimum of two years each in the fields he was to teach. The science instructors of teachers colleges know that these conditions exist, but have not, except in instances, been able to secure the necessary administrative adjustments to permit this ample training for their students which they recommend.

I have been invited to outline here a plan of training science teachers for the high school which, in my judgment, would supply a sound product, adequate both in width of contacts and depth of penetration for the purposes intended. I present this with no desire to be considered oracular, but as a draughtsman showing his blueprints, which are subject to modification.

As a preliminary step, science teachers should work for rules of certification by state departments and other authorities that would put an end to the incongrous combinations of subjects that may be assigned to high school teachers, and limit the permissible programs to groups of one or more of seven subjects—general science, biology, physics, chemistry, mathematics, agriculture, home economics. In addition, certain extra-curricular services should be permitted, such as sponsorship of literary societies, musical affairs, and school athletics, although as a rule these are more in the line of other specialists. After all, most science teachers would like to have permission to teach at least four or five of the sciences named. Some state certification laws are restrictive to the point of absurdity in relation to the true conditions. The multi-science teacher is to be given every encouragement for existence in the high school.

The following schedule outlines the training of teachers for this type of broad yet logical certification for high school instruction. It is presented in terms of required work deemed necessary for the adequate preparation of men and women who, we may assume, are young, recently out of high school, either with or without previous science except probably general

science, and of the proper mental efficiency, moral fiber, and nervous stability that would rate them as good prospective members of the profession.

THE "CONTENT COURSES"

First—Require one year (9 quarter hours) in each of these fields: biology, physics, chemistry, with biology to be taken definitely in the first year.

Second—Require one year (9 quarter hours) in *one* of these fields: mathematics, agriculture, home economics. This should be rather definitely assigned to the second year.

Third—Require the election of an additional year in (a) two sciences, or (b) one science and either mathematics, agriculture, or home economics.

Fourth—Require the election of an additional year—a third—in one of the two subjects followed for the two previous years.

Before proceeding further, let me call attention to the fact that up to this point the program definitely provides for two necessities in the training of science teachers to meet today's conditions: a broad foundation, in which the principles of each science field are acquired in a beginning course; and three years of a specialty, which is as much content as is provided in any workable curriculum in a teachers college. This specialty is buttressed by a two-year experience in a closely related field.

THE "METHODS COURSES"

Now come the provisions for teaching methods, although in my judgment the professor of any science in a teachers' college should give a daily example of what is best, most practical, most modern, in his instruction. The concepts of "professionalized subject matter" are indeed well founded. We science teachers should be the last ones to accept the sneering comment—emanating as a rule from university professors who smoke pipes in their laboratories—that "if a fellow knows his subject that's enough; he'll teach it somehow." There are many things, however, that for various reasons cannot be included in content courses, especially in the earlier years. I have always felt that a course in how to teach should be a sort of climax to the instruction of years; that the students should be of sufficient maturity in the subject to have many original

ideas upon how it ought to be presented; that this maturity should make possible the really effective use of studies and reports of research in the scientific pedagogy of our profession, such as is published liberally by the periodicals sponsored and used by the progressive science teachers of our nation. You could hardly expect a freshman to enthuse over an article printed in SCIENCE EDUCATION; a senior ought to get real information and inspiration from it.

In the courses on teaching methods there is opportunity to give far more of the history of a science than time will permit in the previous years. The human interest side of science—first employed for interest alone—may later reach the importance of content material itself.

The courses in teaching methods give a chance to review the "hard spots" from a standpoint of instruction. Of course the teaching course must not degenerate into a mere "review course," but there are places in every science where grease should be applied, and prospective teachers will profit by a "lubrication chart" that will remove at least some of the obvious causes of wasted energy in the rub of daily teaching.

The courses in teaching methods present opportunity of studying in detail those "tricks of the trade" known as standard tests; these should be presented in the light of interpretation of their results, and statistics in an elementary form should accompany it. There has not been time for this before.

The course in teaching methods make it possible for an instructor with a warm heart to give a final "Godspeed" to his fledgelings. There are some things about how to teach that are simply not in the books.

For these, and many other reasons, I am convinced that the courses in how to teach science should be strictly third or fourth year offerings. They might be divided thus (the sequence continues from the content courses):

Fifth—Require of all science students a course in "The Teaching of General Science." This should last for the entire year, for some two hours each quarter, and include at least the following matters:

(a) Considerable content study in community science, astronomy, geology, meteorology, and the nature of the outdoors. None of these will have been presented adequately in previous courses, yet each is needed for general science instruction.

Even the latter—nature out of doors—has rarely been comprehended sufficiently by the typical student of biology to enable him to take a group of high school youngsters out on a spring hike with confidence. These "content courses" in the midst of the methods course should be seasonal; there should be a study of how to investigate homes, water supply, lighting and heating, and other community matters in the fall, weather in the early spring, outdoor plants and animals in the late spring, astronomy probably bit by bit and month by month.

(b) There should be studies of general reference and supplementary material for science teaching in the high school. My own annual lists[4] are intended for just this purpose in the field of current science books. Prospective teachers should also become acquainted with the magazines, both general and professional, that they will need in the school library. They should learn to appreciate the technique of making and reporting studies in science teaching. "Into your hands the torch we throw"—you know the sentiment.

(c) There should be considerable effort spent on practical methods of doing laboratory work in general science. The prospective teacher should learn how to be reasonably independent of the bright glassware and varnished apparatus of the physical and chemical laboratories, and should acquire to a degree the knack of using the tools, utensils and supplies of the home and kitchen, and to employ as real apparatus the objects gathered in forest and field.

It is time we were developing a better technique of teaching general science, and I know of no way that would do this better than to have a group of earnest professors in teachers colleges seeking constant advice and counsel from each other, offering serious courses in how to teach general science.

Sixth—Require each student in the fourth year to take one course in the teaching of that subject in which he has had three years of study. At present I am of opinion that such a methods course in a science may be given in one quarter, and for three hours credit, though I am also sure that this might be increased with profit. There is, indeed, more than enough material for a full year of methods instruction in each

4 H. A. Webb, "The High School Science Library, 1910-1924," and annual supplements thereafter; bound reprints from "The Peabody Journal of Education," available at small cost.

of the science fields. In my plan, however, allowance is made for a practical arrangement of practice teaching, which—we must admit—is poorly organized or non-existent in a great majority of our teachers colleges when the sciences are considered. There are, of course, certain notable exceptions. The graduate years offer this opportunity in certain situations—as at Harvard, in her two-year graduate course for the Master of Education degree.

Several matters claim consideration in planning this practice teaching in any specific place,—facilities, the attitude of parents, the ever-present difficulties of schedule both for supervisors, teachers, and the taught. There are teachers colleges, however, where satisfactory arrangements for all concerned are worked out.

This final year—devoted primarily to the teaching of science by precept, example and experience—permits a rounding out of knowledge, provides (a boon to many!) a few months in which serious reading outside of specific assignment may be done, and offers in general a helpful culmination of the years of previous efforts.

COUNTING UP

Add all of these requirements in terms of quarter-hours; they involve but 18 quarter-hours per year, with one course—the teaching of general science—brought in near the end for an additional six hours. This amounts to a total of 78 hours for the entire undergraduate course in preparation—both by content and methods courses—for the life of a science teacher. Required credits in terms of quarter-hours are usually slightly under 200 for the Bachelor's degree—in our own institution they are 198. Does it appear that 78 hours—39 per cent—is an unreasonable amount of time to spend on preparation for a specific profession—science teaching—with a foundation of adequate—indeed, of generous—breadth, with storerooms of ample size filled with selected materials, with a pleasing yet sturdy roof of experience, so that the cold winds and rains which every new teacher meets in the first tour into the world, may do no damage and dampen no enthusiasms. A proper curriculum of training for high school science teachers should do just that,—build foundations, fill the storehouse, protect the goods, and permit their use at the proper times.

An Investigation of the Attitude of Physics Teachers Toward the Content of the High School Physics Course

Gerald W. Fox, Iowa State College, and
D. L. Rich, University of Michigan.

This investigation had to do with determining how teachers of physics in high schools and colleges throughout the country feel toward a definite revision of the high school physics course both in subject-matter and point of view. The survey was undertaken as a result of attending a number of educational conferences of teachers of high school physics. At these meetings a feeling of dissatisfaction with the present course was expressed frequently, but no active suggestions were made as to how the course could be made more useful and stimulating to the boys and girls who elect to study it. Most teachers are agreed that students find physics a difficult subject. This is true for the college as well as for the secondary school.

The writers believe the high school physics course needs a thorough revision in both subject-matter and point of view. The materials of physics have become so traditional that the idea seems to be prevalent that they are inviolable. The result is that students beginning the study of physics in 1930 are all too often studying the physics of two generations ago. The question of revision is, however, a delicate one, especially when we consider leaving out some topics altogether; for, judging from the length of the course at present, some things will have to be deleted to make room for the introduction of new topics. The wealth of new material presents another problem. It is hard to say how much of this new subject-matter can be used to advantage. Studies of the content of the course have been made, but the effect has been only a refining of the material already present and the introduction here and there of a paragraph on a new topic.

The method of investigation consisted of tabulating the answers to a questionnaire sent to 1,800 teachers of physics throughout the country. Replies were received from all the states but five. Seventy-seven of the total number of replies were from colleges. The very excellent response, together with the large number of comments and suggestions, leaves no doubt as to the interest of teachers in the ideas proposed, whether or

not they agreed with the ideas. The questionnaire is here printed, so that anyone interested can compare his views with those whose opinions were considered in the compilation. The figures given represent the collation of 1,043 replies.

QUESTIONNAIRE AND ANALYSIS

	All Replies			College Replies		
	Yes %	No %	Total	Yes %	No %	Total
I. The newer developments in Physics should be included in a high school course	98	2	997	90	10	67
A. Reasons for including new material:						
1. The basic ideas of physics have changed greatly in the last forty years	80	20	968	84	16	63
2. The "new physics" has a decided educational and cultural value. The prominence given it in current magazine and newspaper articles is evidence of this	96	4	982	93	7	67
3. The new material CAN be treated accurately and interestingly in such a manner that high school boys and girls can understand it	95	5	981	92	8	63
4. The new ideas are needed to give the beginner an appreciation of modern science	94	6	983	89	11	65
5. The most important function of high school Physics is to give an appreciation of modern science, rather than to prepare the student for Physics in college	91	9	953	93	7	59
6. The new ideas can be introduced without impairing the logical development of the subject	97	3	974	95	5	62
7. Sufficient old material can reasonably be omitted to make room for the new	92	8	941	90	10	64
8. The new subject-matter will present some teaching difficulties, because many teachers know too little about recent developments, but this fact should not be permitted to determine the content of the course	90	10	965	86	14	65

* * * *

B. Suggested material:

1. Very general, completely changing the viewpoint and the presentation.

	All Replies			College Replies		
	% Yes	% No	Total	% Yes	% No	Total
a. The role of the electron in all electric and magnetic phenomena.						
b. The electrical structure of matter and the transmutation of the elements.						
c. The new fields of significant knowledge opened up by modern spectroscopy.						
d. The significance and the unity of the entire radiation spectrum.						
e. The modern conception of quanta, and the discontinuity of energy.						
f. The universe from the standpoint of the convertibility of matter into energy and back again.						
2. Some minor details of recent practical developments, such as ultraviolet therapy, modern illumination, color photography, talking movies, television, aeroplane design, natural mechanical reproduction of sound, architectural acoustics, heat treatment and new alloys, sound ranging applied to depth determinations, measurements of speech and hearing and noise, modern refrigeration, etc., etc.,—a host of things with which boys and girls of today come into contact, which were unheard of a generation ago.						
3. On the back of this sheet suggest other new material.						
* * * *						
II. Some old material can be condensed, some treated less extensively, and some even omitted..	97	3	923	94	6	64
A. Reasons for changes in treatment of old material:						
1. The commonly accepted material of elementary Physics was fixed very largely by earlier textbooks published from thirty to fifty years ago. The student of today should study the world of 1929 rather than the the world of his grandfathers	95	5	923	90	10	55
2. A few topics have largely outlived their usefulness and should be discarded	94	6	966	92	8	68
3. Because of the wealth of new material, certain topics can be omitted without impairing the logical development of the subject	95	5	972	92	8	67
4. Many ideas really belonging to high school Physics may, in view of modern conditions, have their treatment somewhat abridged	93	7	935	90	10	66

	All Replies			College Replies		
	% Yes	% No	Total	% Yes	% No	Total
5. Physics exists independently of mathematics. The interpretation of Physics in terms of mathematical formulae is not the chief object of the study of Physics, and should not be stressed as such	74	26	909	83	17	66
6. The background of experience possessed by boys and girls of today differs so radically from that of 30 and 40 years ago, that the classical presentation of Physics is no longer the proper method of approach	86	14	927	84	16	62
* * * *						
B. Suggested changes that will save space:						
1. Do not try to include everything. Place less emphasis on the learning of bare facts	90	10	899	90	10	65
2. Place less emphasis on mathematical computations and mathematical formulation	68	32	945	74	26	65
3. Place less emphasis on the engineering aspect of Physics	65	35	897	67	33	60
4. Without omitting essentials, condense and reduce the treatment of mechanics	83	17	962	85	15	64
5. Give less attention to precision measurements in mechanics	70	30	925	82	18	62
6. Reduce the treatment of the mechanics of the vibrations of strings and pipes	79	21	930	75	25	62
4. Reduce the space given to thermometry	64	36	907	74	26	63
8. Avoid the duplication so common in the treatment of geometrical optics...	95	5	961	93	7	60
9. Do not treat at length electrical apparatus that is out of date, such as wet Leclanche cells, tangent galvanometers, obsolete electric lamps, etc.	99	1	1032	94	6	66
10. On the back of this sheet suggest some more topics that you think might well be treated less extensively.						

DISCUSSION

It is to be noted that the college teachers are slightly less favorable to the suggested changes than are the high school teachers. It did not seem worth while to make a separate compilation of the high school replies, as there is no really significant difference between the two compilations shown. The fact that over eighty per cent of the replies contained written comment, often in the form of a letter, in addition to voting checks, makes it apparent that the suggestions provoked considerable discussion. In many instances the opinions registered were stated to be the result of a conference of the entire science department in the school.

None of the suggestions received unanimous approval or disapproval, though the ideas in the first part (I-A1—I-A8) received a very favorable reception except for statement (1-A2). The analysis shows a large number of teachers strongly in favor of rigorous mathematical treatment and a continued emphasis on the engineering aspect of physics. Likewise many do not favor less emphasis on thermometry, precision measurements and vibrations in strings and pipes. It seems apparent from this part of the questionnaire that revision of subject-matter involving less emphasis on any of the old timeworn topics will meet with severe opposition. On the other hand, if one lists all the omissions suggested (II-B10), one notes the widest diversity of opinion. Topics favored by one are suggested omissions by another, so that no conclusions can be drawn.

With reference to the suggested new material, most every one was interested in such ideas as the role of the electron in electric and magnetic phenomena, the convertibility of matter into radiation and back again, and the unity of the radiation spectrum, but many felt convinced that such ideas were beyond the grasp of high school students. Practical developments, such as those of (I-B2) received nearly complete approval. A great number of additional topics were listed, each teacher, so far as could be judged, suggesting those most interesting to him—perhaps even his hobbies.

What Constitutes a Desirable Program of Studies in Science Education for Teachers of Science in Secondary Education? [1]

FRANCIS D. CURTIS, University of Michigan

In this present age, when every citizen is expected to possess some knowledge of scientific facts and principles, there is probably no teacher upon whose shoulders rests a heavier responsibility than the teacher of science in the secondary school. Realizing this fact, teacher-training institutions are devoting an increasingly great amount of attention to the various problems involved in the preparation of science teachers.

In considering the question, "What constitutes a desirable program of studies in science education for teachers of science in secondary schools?" we must first consider the nature of the product which we wish to obtain as a result of this training. We must then select as curricular principles underlying the selection of courses and subject-matter, those which seem most likely to contribute to the securing of the kind of science teacher we want to produce.

While there is likely to be considerable difference of opinion regarding the essential equipment of a teacher for any specific situation, it is likely that most educators would agree that teacher-training institutions should endeavor to turn out teachers who possess, among others, the following qualifications:

1. The beginning teacher must be adequately prepared in the subject-matter and in the fundamental principles underlying the courses he is to teach.

2. He must possess an adequate background of educational principles, theory, and practice.

3. He must know how to apply in actual classroom situations the theory he has learned, that is, he must be possessed of some at least of the essential teaching skills.

4. He must be a well-rounded individual with knowledges and interests beyond those demanded by the mere teaching of the subject-matter of science.

With the nature of the desired product clearly in mind, we are able to formulate some of the principles of curricular con-

1 Delivered at the Science Conference held in connection with the dedication of the Education Building of New York University, March 1, 1930.

struction which will assist in the securing of this product. This discussion will deal briefly with six of these principles.

1. *The curriculum shall be planned, not in accordance with theoretical considerations or ideal conditions, but, in order to train prospective teachers of science in secondary schools for the teaching situation which the available evidence indicates they will actually meet in the field.*

Recent studies of the teaching of science, made in various parts of the country by Woody, Koos, Finley, Caldwell, and many others, furnish abundant support for the statement that the position of science teacher in our secondary schools is at present an anomalous one.[2] Teachers having no aptitude or inclination for teaching science, and with no scientific training whatever are, nevertheless, attempting to teach courses in science; teachers well grounded in certain subject-matter branches of science are teaching classes only in other branches in which they have little or no foundation. The evidence shows that even in large city systems there is by no means a certainty that the teacher of science, especially during his first year in a school, will be assigned to teach the branches of science which he has prepared himself to teach. In the smaller village high schools, in which there is usually only one teacher of science, the situation is inevitably much worse Here the teacher must of necessity attempt to teach not only whatever branches of science are offered in the school, but also, in order to complete his five- or six-hour teaching schedule, one or more other subjects for which he may have no training whatever; and in addition he will probably be expected to sponsor one or more extra-curricular activities. It is in the smaller high schools, moreover, that the beginning teacher who is graduated from our teacher-training institutions, must expect to make his start. At the time when he is practically without experience and has little more than a theoretical knowledge of how to teach, he is called upon to face the most exacting and difficult situation which his entire teaching career is likely to embrace.

While we are not responsible for and can do little or nothing, perhaps, to help the situation in which, for example, a history

2 References to these studies will be found in the monograph by Charles W. Finley, "Biology in Secondary Schools and the Training of Biology Teachers," Teachers College Contributions to Education, No. 199, pp. 69-73.

major with no scientific training is scheduled to teach courses in general science and biology, we *are* responsible for, and should take steps at once to eliminate the situation in which a science teacher finds himself assigned to a branch of science in which he has had no training whatever. We can and must insure that every beginning teacher whom we certify to teach any branch of science will have had at the end of his four-year course, some acquaintance with every branch of science which he is likely later to be called upon to teach.

The acceptance of this thesis by teacher-training institutions means that in the curriculum for prospective teachers of science in high schools, a broad general foundation of scientific knowledge with non-extensive specialization must be substituted for the extensive specialization in one branch of science with no knowledge of others, which all too frequently now constitutes the beginning teacher's major equipment. In support of this thesis, the point should be emphasized that such a plan does not make it impossible for the prospective teacher to specialize; it merely limits the *amount* of specialization possible during the four undergraduate years. The teacher may subsequently specialize in his favorite branch of science to any extent he chooses in his pursuit of graduate degrees.

The curriculum planned to provide the broad background of science for every prospective teacher of science should include introductory courses totalling eight hours each in biology, physics, and chemistry, and three each in astronomy and geology. Training in the general field of biology is urged in preference to that in specific fields of biology and zoology, for the reason that biology is so rapidly displacing separate courses of botany and zoology in secondary schools. It is true that astronomy and geology, or rather physiography, are now offered as separate courses in relatively few secondary schools; but considering the rapid and increasing spread of general science, and considering, too, the evidence which indicates that a large majority of the science teachers who begin their teaching in the smaller high schools are called upon sooner or later to teach general science, it seems sensible to include introductory courses in astronomy and geology among the minimal essentials required of every prospective teacher of science, since these courses are admitted to be essential equipment for teaching general science. Moreover, aside from all considerations of

general science, even though the teacher may never subsequently be called upon to teach more than one or two branches of science, he will, nevertheless, almost certainly teach these better for having had some training also in other branches.

It is perhaps apropos at this point to digress from the main discussion long enough to discuss further the training of the teacher of general science. In a number of teacher-training institutions a survey course is offered in which each of the main divisions of science is briefly but intensively considered. There is undoubtedly a place for a course of this type in every college or university; but its chief value lies perhaps in affording to the student who has studied little or no science before entering college, and who intends to pursue the subject no further, a brief glimpse of the world of science. Such a course, however, should never be considered as furnishing adequate training for the teacher of general science, nor can it effectively be substituted in the teacher-training program for introductory courses in any of the five branches previously enumerated.

Merely to require that every candidate for a certificate to teach science in high schools must elect introductory courses totalling thirty semester hours in the five branches of science enumerated, does not by any means insure that the introductory courses available for his election will provide the proper foundation. The introductory courses in science now offered in universities and colleges are not commonly designed for teacher-training purposes; they are, therefore, as a rule illy suited to the needs of prospective teachers of science. For example, the prospective teacher of high school biology needs an altogether different sort of introductory course from the conventional pre-specialization courses in botany and zoology; the prospective teacher of physics and chemistry needs courses differing radically from the present pre-engineering and pre-technical courses in these fields.

Introductory courses for teachers of science should include the principles and subject-matter embraced in the corresponding high school courses, but should extend and enrich these materials substantially. The introductory course in biology should put its major stress upon the natural history of plants and animals and the interrelations of the organic and inorganic worlds as these illustrate and make clear the fundamental prin-

ciples of biology; the student should not only gain a substantial background of knowledge about plant and animal life in general, but, through numerous field trips, should gain a practical acquaintance with the life problems of some of the more common plants and animals.

In the courses in physics and chemistry the amount of mathematical problem solving should be reduced in order to provide more time for discussions of practical applications of principles and subject-matter to everyday life situations. The course in elementary astronomy should be confined largely to a study of the solar system, with elementary discussions of the underlying principles of astronomy and the methods of the astronomer. The course in elementary geology should give an understanding of the principles of geology, of the agents at work upon the earth, and of the origin and development of resultant land forms; it should also include an introduction to the more important phases of meteorology.

2. *The prospective teacher of science, having acquired an adequate general background of the subject-matter of science, should elect advanced work in one or perhaps two branches of science.* In planning such specialization one must steer a careful course between the Scylla of insufficient specialization and the Charybdis of specialization so extensive as to leave little or no opportunity for the student to elect work in other fields essential to his all-round training. Considering that the student has already studied eight semester hours of introductory work each in physics, chemistry and biology, it seems reasonable to limit the amount of advanced work in physics, chemistry, zoology, or botany to sixteen semester hours, or if, as seems more desirable from the standpoint of teacher-training, the student wishes to elect advanced work in a combination of either the physical or the biological sciences, to limit such combined major to twenty-four semester hours. Such a program, devoting about 40 per cent of the prospective teacher's time to the acquirement of subject-matter in the teaching major and minor, is large when considered with respect to what one would like a college education to include. This subject-matter requirement, however, seems not unreasonable for a strictly professional curriculum which must fit the prospective teacher adequately to teach several branches of science.

If the major is botany, it should include, in addition to the introductory course, a selection from courses in morphology of plants, systematic botany, microbiology, plant physiology, plant anatomy, ecology, micrology and pathology, and genetics. If the major is zoology, it should include, in addition to the introductory course in biology, a selection from courses in invertebrate zoology, entomology, comparative anatomy and physiology of vertebrates, and natural history of vertebrates. If the major is biology, it should include, in addition to the introductory course, an election of about an equal number of hours each in botany and zoology, and should include among these elections courses in systematic botany, entomology, and comparative anatomy of vertebrates. If the major is physics, it should include courses in electrical measurements, light, heat, sound, and mechanics. If the major is chemistry, it should include courses in qualitative and quantitative analysis, and organic chemistry. If the major is the physical sciences, the elections should include about an equal number of courses each in advanced physics and chemistry, and should include as minimal essentials courses in electrical measurements, qualitative and quantitative analysis, and organic chemistry.

The distribution of the science courses should be given careful consideration. It is neither practicable nor desirable to concentrate too many laboratory courses in the first year. The prospective teacher of science should plan to include in his program about eight hours of science during each of the first four semesters, in order to complete the introductory courses in biology, physics, and chemistry in the freshman and sophomore years.

The proponents for more extensive subject-matter preparation for the teaching of science should keep in mind that with the present increasing demand for the master's degree as a requirement for the high school teacher, the prospective teacher must consider the bachelor's degree as only a beginning, and may therefore plan to continue his specialization in his preferred field of science as part of his graduate work.

3. *The prospective teacher of science must acquire a thorough grounding in the theory and practice of teaching.* This work in education should include courses in educational psy-

chology, educational measurements, philosophy of education, principles of secondary education, and methods as applied specifically to the teaching of science, exemplified and made concrete to the prospective teacher through the medium of professionalized subject matter and directed teaching. This heavy program can be included in fifteen hours; but only by a careful limiting of each course to essentials, and by a careful comparison of the various courses to prevent overlapping. These courses in education should be given during the junior and senior years, with the course in professionalized subject matter and the work in directed teaching coming during the last semester of the senior year.

The course in professionalized subject-matter should make a review of the subject-matter and the principles of the high school course the basis for practical exercises in conducting demonstrations and laboratory work, in directing study, drill, review, projects, and other methods, devices and practices.

The directed teaching to be most effective should probably be of the type in which the prospective teacher is apprenticed for a semester to a regular teacher of unusual skill in a typical high school. The apprentice-teacher carefully prepares every day's work but does little actual teaching at first. After a week or so the apprentice is given charge of the class for a few minutes at a time, during which he covers small units which he has previously carefully planned and rehearsed with the critic-teacher. Little by little, as the apprentice-teacher gains skill and confidence, he is given more and more of the teaching to do, and finally, toward the close of the term, is given complete charge of the class for one or perhaps two periods. The critic teacher, however, is always present while the apprentice is teaching, and the frequent conferences between the critic teacher and the apprentice are devoted largely to a discussion of the small units which the apprentice-teacher has taught.

An experiment now in progress at the University of Michigan confines all the work in education to one correlated course which occupies the entire time of the student during one whole semester. This experiment is only in its initial phases, yet

the results seem promising and seem to offer some positive advantages not previously achieved in that school through the medium of separate courses in education.

4. *Since instruction is only one important responsibility and duty of the teacher of science, the curriculum for the training of science teachers must include certain courses which may legitimately be considered as part of the professional training of the teacher, but which are neither in the subject-matter of science nor in education.* So much of the success of a teacher depends upon his understanding of pupils and his sympathy with them. It is therefore highly desirable that the prospective teacher precede his work in educational psychology with a course in general psychology, and to add to this during the senior year a course in abnormal psychology treating with the simpler and more common deviations from the normal. The beginning teacher's chances for success will, moreover, be greatly enhanced by the possession of some understanding of social relations. It is therefore urged also that the curriculum for the prospective teacher include a course in the principles of sociology and another in the elements of economics, these to be followed by a brief course in social problems, such as poverty, crime, religion, immigration, and labor. These last three courses, together totalling about nine hours, should be made elective during any year except the first.

In summarizing the curriculum requirements determined on the basis of the four principles of curricular construction already discussed, it will be noted that the approximate number of hours in required courses totals between seventy-four and eighty-two semester hours distributed as follows: Courses in the subject-matter of science—forty-six to fifty-four hours; courses in education—fifteen hours; courses in psychology and sociology — thirteen hours. These requirements leave only about forty hours entirely free for election of courses other than those which bear more or less directly upon the preparation for the position as teacher of science. This is not a large provision for electives. It must be kept in mind, however, that the teacher training curriculum is a *strictly professional curriculum* and therefore, like every other professional cur-

riculum, it must, of necessity, include a large proportion of required courses.

5. *To combat the narrowing influences of extreme specialization, the prospective teacher of science shall be encouraged to gain an acquaintance with cultural fields to the end that these may serve him as foundation and background for completer living and for a pleasant avocation during his leisure hours.* There is probably no profession in which the demand for well-rounded individuals is more acute than in the profession of teaching. The desire for extreme specialization must not be allowed to deprive the prospective teacher of at least a brief acquaintance with cultural fields important in everyday life and far removed from the field of science. Such cultural fields include history, literature, music, and art. These courses belong in the catagory of free electives and should be distributed through the four years.

6. *To be maximally effective the teacher-training program must extend beyond the undergraduate years in order to provide for the continued growth of the teacher in service.* Such provision should include graduate and undergraduate courses in subject-matter, professional and cognate courses, carefully planned as an integrated curriculum to fit the needs of each individual, and if possible, to emphasize the gaining of increasing fitness for the work of teaching science, rather than of acquiring graduate degrees.

The program aiming to promote the growth and improvement of the teacher must not, however, end with the teacher who is pursuing further study on the campus. Of equal or perhaps greater importance is the growth of the teacher who is not in attendance at the regular or the summer session. For this teacher opportunity and encouragement should be given to study further in extension or correspondence courses or in both; to attend extension lectures and to take part in week-end conferences conducted in convenient centers; to avail himself of the services of a special bureau maintained by each teacher-training institution for the purpose of helping the teacher in all ways to solve his problems.

A program including these and other features designed for

the improvement of the science teacher in service presents alluring possibilities for developments which as yet have scarcely begun to be realized.

SUMMARY

The program here proposed for the training of teachers of science in secondary schools will be seen to stress the following features as essential:

1. An introduction to the six major branches of science, an acquaintance with which seems, from available evidence, most likely to be needed subsequently by the prospective teacher.
2. A further study of one or perhaps two of these branches of science to serve the prospective teacher
   a. As more adequate equipment for teaching, and
   b. As a foundation for further specialization in post-baccalaureate study.
3. A practical grounding in education with special emphasis upon the theory and practice of teaching made practical through the medium of professionalized subject-matter and apprentice-teaching.
4. A brief introduction to the cognate fields of psychology, sociology and economics.
5. A brief introduction to one or more cultural fields.
6. A program for encouraging and promoting the continued growth of teachers in service.

The Measurement of Nature Study in the Primary Grades in the Detroit Public Schools*

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In Detroit, educational tests are an integral part of the instructional program. A test, to be of greatest use, will be valuable to the pupil, the teacher, and the supervisor. It will assist the pupil in his appraisal of himself. It will assist the teacher in her appraisal of the pupils' work and of her own teaching, and finally, it will assist the supervisor in her apprai-

* Read before the American Nature Study Society Section of the American Association for the Advancement of Science, in Des Moines, Iowa, December, 1929.

sal of the work of the pupils, the teacher, and herself and her own course of study.

Two years ago the supervisor of nature study in Detroit, with the aid of the writer, designed an elementary science test for use in the primary grades. In grades one and two, elementary science consists of nature study. The test which was built is made up of items which are samplings of the work covered in these two grades. The test parallels the course of study. It was decided, however, to use the test in grade 2A only. In constructing the test the builders tried to adhere to the principles of good test construction.

In the building of any test or in the measurement of any educational trait the test builder must consider two things. First, he must consider the nature of the child for whom the test is being prepared. By the nature of the child is meant such characteristics as grade, sex, mental level, control over language, and the like. Second, he must consider the quality of the trait or the nature of the subject matter that he wishes to measure.

Since a good test must measure the trait or the ability which it is intended to measure, it should not be dependent upon some other ability which is not well developed in the pupils being measured. It seemed desirable then, in the building of a Nature Study test, to construct one which would not measure reading. Hence the tests were designed to be read by the teacher while the pupil recorded his answer on a form provided him. After the tests have been distributed to the pupils and the blanks filled in at the top of the page, the teacher reads, "A rose is (a weed, a garden flower, a vegetable)," and the pupil draws a line under *garden flower*. After the pupils understand what to do the teacher begins with the "Real Test." She reads "No. 1. The fly is (a plant, a bird, an insect)." This procedure is followed for items 1 through 32.

The remainder of the test is designed to measure the ability to recognize pictures of objects in nature. After giving a Practice Test on this type, the teacher reads "No. 33, Spruce tree." The pupil puts his finger on No. 33. He then finds the picture of the spruce tree and draws a line from the word to the picture. This procedure is continued to the end of the test.

ELEMENTARY SCIENCE

Detroit Public Schools | Nature Study—Test 1 Form E | Department of Research

Name ..... Score .....

School ..... Section ..... Grade .....

Date ..... Age ..... Group .....

Practice Test

A. Weed .....garden flower .....vegetable

B. Cage .....woods .....field

Real Test

1. plant .....bird .....insect
2. live here .....die .....go south
3. carry disease ...destroy other insects...spoil food
4. yes .....no .....I do not know
5. 4 .....6 8
6. red .....blue .....yellow
7. spring .....summer .....fall
8. weed .....wild flower .....garden flower
9. trilliums .....dandelions .....pansies
10. leaf .....root .....seeds
11. yes .....no .....I do not know
12. weeds .....trees .....vines
13. winged .....clinging .....rolling
14. broad .....lobed .....like needles

Devised by L. Lenore Conover, H. Inez Hart, and Manley E. Irwin.
Illustrated by Eunice Devine.

a	33. spruce tree 34. maple tree	b
c	35. elm tree 36. poplar tree	d
e	37. acorn 38. potato	f
g	39. bud 40. bulb	h
i	41. horse chestnut fruit 42. elm fruit	j
k	43. peanut 44. maple fruit	l
m	45. dandelion 46. rose	n

Although, in Detroit, nature study is taught in grades 1B, 1A, 2B, and 2A, these tests are used in grade 2A primarily. Form E is used in grade 2A as an initial test in September; Form F is used as the final test in January. Form G is used as an initial test in February, and Form H is used as the final test in June.

After the test has been given, the teacher makes a distribution of the scores and computes the median score of her class. The median scores for the classes are reported to the Research Department. This department makes a distribution of the class medians for the city and computes the city median.

TABLE I. *Distribution of Class Medians — Detroit Nature Study Test*

Score	Initial				Final			
	X	Y	Z	Whole Class	X	Y	Z	Whole Class
60	..	..	..	..	..	..	..	..
57-59	..	..	..	..	2	..	..	..
54-56	..	..	..	..	3	2	..	3
51-53	1	..	..	..	7	8	4	5
48-50	2	..	1	1	12	5	4	7
45-47	2	2	1	2	14	10	8	15
42-44	10	3	1	3	17	17	7	14
39-41	16	13	4	15	11	26	13	27
36-38	16	36	9	25	12	22	13	25
33-35	14	20	17	29	3	14	15	17
30-32	10	27	16	21	2	8	15	7
27-29	..	10	19	..	1	1	5	4
24-26	2	3	9	18	..	..	3	2
21-23	..	43	6	5	..	..	1	..
18-20	..	..	1	2	..	..	3	..
15-17	..	2	1	2	..	..	..	..
12-14	..	1	1	..	..	..	..	..
9-11	..	..	..	..	..	..	..	..
6-8	..	..	1	..	..	..	..	..
3-5	..	..	..	..	..	..	..	..
0-2	1	..	1	..	..	..	..	..
Total	74	160	88	123	84	113	91	126
Median	37.9	32.3	30.9	34.4	44.3	40.3	36.8	39.9
Gain	..	..	..	..	6.4	8.0	6.1	5.5

In Table I is shown the city distribution of class medians by X, Y, Z, and whole class groups. On the initial test of February, 1928, one of the seventy-four classes of X pupils, made up of those pupils whose general intelligence is high, had a median score of 51-53, two classes had a median of 48-50, and so on, but one class of these X pupils made a median score of only 0-2. The median of these seventy-four X classes

is 37.9. The city median for the 160 classes of Y pupils, made up of those pupils whose general intelligence is average, is 32.3, the median for the 88 classes of Z pupils, made up of those pupils whose general intelligence is low, is 30.9, and the median score for the 123 whole classes who had not been reported by X, Y, or Z is 34.4.

In the final test of the following June it will be noted that the classes as a whole in the various groups made some gain over the initial test. The X classes made a gain of 6.4 points, the Y classes 8.0 points, the Z classes 6.1 points, and the whole class groups 5.5 points. It will be seen that the overlapping is very great, not only among the groups, but between the initial and final tests of each group. For example, some X classes made a higher score on the initial test than the average X classes made on the final test, and several Y classes made higher scores than the average X classes. The same is true for other comparisons.

Not only is there a great spread in the distribution of the median scores made by classes, but the spread of the distribution of scores made by the individuals in a class is just as large. Form E was given to pupils in grades 2A, 3A, 4A, and 5A in a typical school in Detroit. It was found that in grade 2A, one pupil made a score of 16 and another made a score of 54. The class median was 35.9. On the same day the pupils in grade 3A made a median score of 39.2, the pupils in grade 4A made 38.5, and the pupils in grade 5A made a median score of 37.5. The overlapping in these grades was very large. The results are given in Table II.

In Detroit no formal instruction is given in nature study beyond grade 2A. It would seem then that, on the whole, pupils retain through grade 5A the nature study information they learn in grades one and two. It would also seem that they do not learn very much in the way of nature study after formal instruction has ceased.

A study was made to discover the difficulty of the various items and to determine the discriminating power of each. For purposes of this study the pupils who made a score below the average for the class were called "Poor" and those who made a score above the average were called "Good." The percentage of the poor pupils meeting success on each item was computed. The same was done for the good pupils. Partial results are

given in Table III. Item No. 2 is said to be high in its discriminating power because sixteen percent of the poor pupils were successful, while fifty percent of the good pupils were successful. The items under "high" are said to have a high discriminating power. Item No. 4 is not as hard as

TABLE II. *Distribution of Individual Scores — Poe School, Detroit*

Score	2A	3A	4A	5A
60	..	..	..	..
55-59	..	1	..	..
50-54	2	3	2	1
45-49	3	7	5	3
40-44	6	8	9	10
35-39	11	13	10	12
30-34	8	6	5	5
25-29	6	3	4	..
20-24	3	1	2	4
15-19	1	..	1	3
10-14	..	..	..	2
5-9	..	..	..	..
0-4	..	..	..	..
Total	40	42	38	40
Median	35.9	39.2	38.5	37.5

No. 2. Items No. 2, No. 4, No. 29, and No. 32, are in the question-answer division of the test, while the next four, 35, 39, 53, and 58, are in the picture-recognition division. Item No. 35 is very hard for both the good and the poor pupils.

TABLE III. *Discriminating Power of Items— Detroit Nature Study Test, Form E*

	High			*Low*	
Item	*Poor*	*Good*	*Item*	*Poor*	*Good*
2	16	50	9	32	33
4	42	72	13	21	22
29	47	89	19	84	72
32	37	83	28	53	50
35	5	28	43	90	89
39	58	83	45	100	100
53	16	56	49	5	17
58	21	56	55	100	89

The items under "Low" in Table III are those that have a low discriminating power. On item No. 9 the poor pupils do as well as the good pupils. The same is true of item No. 13. Items No. 19 and No. 28 are easier for the poor pupils than for those who are good. The items that call for a recog-

nition of pictures (Items No. 35, 39, 53, and 58) are very easy, both for the good and for the poor pupils, while one item, No. 49, is too hard. Only one pupil in six was successful in answering this item correctly.

TABLE IV. *Effect of Maturity—Detroit Nature Study Test*

Item No.	*Subject*	*Percentage of Able Pupils Meeting Success*			
		2A	3A	4A	5A
2	Butterfly	88	50	33	19
4	Caterpillar	82	72	44	50
19	Bird	59	72	83	86
32	Season	76	83	83	91
34	Maple Tree	28	59	67	64
41	Tree Fruit	72	82	94	91
43	Peanut	89	88	94	100
45	Dandelion	100	100	100	100
49	Orion	17	18	22	18
58	Moth	56	59	67	73

In Table II it was pointed out that the more mature pupils, that is those in the grades succeeding 2A, did little if any better on the test as a whole than pupils in the grade for which the test was intended. Table IV shows the effect of maturity upon the ability of pupils to answer the questions correctly. Item No. 2, which is a question about butterflies, was answered correctly by 88% of the able or good pupils in grade 2A, by 50% of the able pupils in grade 3A, by 33% of the able pupils in grade 4A, and by 19% of the able pupils in grade 5A. Item No. 4, which is a question about caterpillars, shows the same condition, only to a less degree. Items No. 19 and No. 32, which are questions on birds and seasons, show that pupils grow with maturity in their ability to answer correctly these items. Item No. 45 is very easy for all children in Detroit. Item No. 49, which is a question in astronomy, is not answered correctly by pupils in grade 2A, nor is it answered correctly in the three succeeding grades. Of course it may be that the picture of this particular group of stars in the test is not good. Nevertheless, since the test is a fair sampling of the instructional material, the supervisor needs to consider the advisability of retaining such subject matter as part of the regular work of the course. It is true that pupils in grade 2A can learn about butterflies and caterpillars. However, if they are not able to retain their understanding of these

topics and have no opportunity to see and to study real butterflies and caterpillars in life, the supervisor may need to study more carefully the grade placement of this subject matter. It would seem from Table IV, that knowledge of birds, seasons, and trees becomes a part of the child's life, and through his experience and reading in the succeeding grades he becomes better acquainted with these topics. No doubt the nature study work in the primary grades has stimulated an interest in these subjects which has carried over to upper grades.

TABLE V. *Difficulty of Classified Items — Detroit Nature Study Test*

Poor Pupils Grades				*Classification**		*Good Pupils Grades*			
2	3	4	5			2	3	4	5
49	73	67	49	Insects	(9)	74	83	81	78
64	74	70	71	Flowers	(6)	80	88	83	82
78	77	94	84	Vegetables	(4)	86	96	93	88
32	24	39	34	Trees	(7)	58	44	66	46
52	64	56	54	Birds	(12)	66	76	73	75
59	60	67	66	Mammals	(8)	68	79	79	73
32	26	38	34	Astron. & Weath.	(7)	47	45	46	45
59	58	43	64	Fruits	(5)	66	62	63	72
100	100	94	100	Weeds	(1)	100	100	100	100

* Item No. 40 was omitted. For convenience all animals except birds are classified under mammals.

Table V shows the difficulty of the nine topics into which the various items have been classified. Nine items in the test are classified under insects, six under flowers, four under vegetables, seven under trees, twelve under birds, eight under mammals, seven under astronomy and weather, five under fruits, and one under weeds. On the left is shown the average percentage of poor pupils in grades two through five who answered the items in these topics correctly. On the right is shown the average percentage of good pupils in grades two through five who were successful in answering the items in these topics. The poor pupils in grade five can answer the questions on insects no better than the poor pupils in grade two. The same is true of the good pupils. The questions on insects were answered successfully by 74 per cent of the pupils in grade two and by only 78 per cent of the good pupils in grade five.

On the whole it seems that pupils do not learn very much about nature items included in the course of study after formal instruction has ceased.

The Detroit Nature Study Test does not attempt to measure directly the child's appreciation of nature nor his attitude toward nature. It does not attempt to measure the impulses of unnecessary fear in the pupil nor his desire to kill. It does attempt to measure his recognition of pictures of mammals, birds, insects, trees, and the like, and his ability to answer some questions about natural phenomena.

It is true that the facts included in the test are only by-products of the activities that are carried on in nature study instruction. However, it is generally conceded that those who have a great deal of interest in the subject and who have learned to love nature are the ones who know many facts concerning the topics in this test.

The promotion of pupils from one grade to another is not dependent upon the scores made on the test. The test is an instructional aid. It helps the teacher to find the particular parts of the course in which a pupil may be strong or weak. If a pupil is strong on the part of the work dealing with birds and weak on the part dealing with trees, the teacher may help him to see that he needs to strengthen his work on trees before he can go on successfully with his study of birds. The initial test becomes a game with the children in which they try to make a high score. The final test is likewise a game in which pupils try to beat their own previous record.

To summarize, the initial and the final tests serve three agents. First, they serve the pupils. The initial test gives the pupil a pre-view of the work that he must cover for the semester. It also gives him a check on the number of facts he already knows and the pictures of objects in nature that he can already recognize, while the final test helps him to appraise himself. Second, the tests serve the teacher. The initial test aids the teacher in her classification of the pupils at the beginning of the semester. From test results she is able to determine the type of work needed by the different individuals in her class. Some pupils will need special help on birds, others on insects, and still others on trees. Each individual has his special problem. Third, the tests serve the supervisor. The initial test gives the supervisor a check on the effectiveness of the work in grades 1B through 2B. The final test gives her an appraisal of the work of the pupil, of the teacher, and of herself. With these tests she may appraise her course of study and take steps toward determining what to teach, where to teach it, and by what method.

Certain Vocabulary Problems in High School Chemistry[1]

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Problems of general reading vocabulary have been extensively investigated during the past fifteen years. Probably the best-known work in this field is Thorndike's determination, by extensive word counts in representative reading matter, of the ten thousand most common words in the English language.[2] More recently, problems of technical vocabulary in the various school subjects have received attention. Thus L. C. Pressey has, by a somewhat complex method[3], made an extensive study of the technical terms in nineteen elementary and secondary school subjects. Powers[4] has by word counts in high school science texts and miscellaneous popular scientific material, made up lists of the most important technical terms in high school science not in the Teacher's Word Book.

These last two studies, though dealing with technical vocabulary, still did not specialize to as great an extent as would seem for many purposes desirable. The writer therefore decided to make an intensive study of certain portions of technical vocabulary in Chemistry. It was felt that the results might be of some value in themselves, and the methods perhaps of more general interest. It should be realized, in this connection, that the technical terms of a subject are more than simply a list of words; they are to a very important extent a catalog of the important concepts, ideas, facts, things, dealt with in that subject. Such intensive study as the writer proposed should then have very interesting bearings on content

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1 The paper summarizes work done in partial requirement for the doctor's degree at the Ohio State University. The writer wishes to express his obligation to Dr. S. L. Pressey for guidance and assistance in this work.

2 Thorndike, E. L. The Teacher's Word Book, Teachers College Bureau of Publications, 1921, 134 pp.

3 Pressey, L. C., The Technical Vocabularies of the Public School Subjects, "School and Society," Vol. 20, pp. 91-96, 1924. Briefly the first step in deriving the lists consisted in having readers go over the most widely used texts in each subject, and list all terms they considered either technical or unusual; this work was continued until the last three readings added less than one percent new words. The list for each subject was then gone over by a group of teachers of that subject, who checked twice those words they considered essential and once the terms they considered important though not essential. The final lists consist of all the words occurring at least a fourth of the possible number of check marks, or appearing in a third or more of the texts studied.

4 Powers, S. R. "A Vocabulary Study of Scientific Terms for High School Students," "Teachers College Record, Vol. 28, No. 3, November 1926.

and method, as well as terminology, in the subject concerned.

CLASSIFICATION OF TECHNICAL TERMS IN CHEMISTRY

Powers found that the two high school chemistry texts he studied averaged 1600 words outside the Thorndike list of the most common ten thousand; presumably most, though not all, of these 1660 words were technical. Mrs. Pressey's list of technical terms in high school chemistry contains 1463 terms. Of the 1463, 348 were in the Thorndike list of the ten thousand most common words. There are 583 terms appearing in the chemistry list only (are not found in the general science, physics, biology, home economics, or other of the technical vocabularies also determined in this investigation). Of the remaining 880 words, 129 are found in all the other sciences, some are common only to chemistry and physics—the details of these interrelationships have been reported elsewhere,[5] and there is space here only to point out the variety of relationships which technical terms may have and the consequent richness of significance which vocabulary studies may have in this connection.

Since the technical vocabulary in the subject is thus sizable, some classification of the terms seemed necessary as a first step toward any intensive investigation in the field. After study of the organization of subject matter in various texts, consultation with high school chemistry teachers, and trial of various schemes, the plan shown below (but carried out with extensive sub-heads not included here) was finally tentatively adopted. The writer then classified the terms in Mrs. Pressey's list according to this scheme.[6] The numbers in the table under each head show the number in this list, which were considered to fall in that category.

Careful study of this classified list showed that the various groups varied greatly as to the range, definiteness, and importance of the terms included. It was clear that not even the technical vocabulary of a single subject is a homogeneous list

5 Livingston, Ralph. "The Interrelations of the Vocabularies in Public School Subjects," unpublished Master's thesis, Ohio State University, summarized in the "Educational Research Bulletin," Vol. 5, pp. 208-214, 1926.

6 This list was used in preference to Powers' because it was found that his omission of all terms appearing in the Thorndike Word Book had left out many terms having, in Chemistry, such a special and often difficult technical significance as to make his list inadequate for the purpose in hand. It was also based on fewer Chemistry texts than was Mrs. Pressey's list.

of terms, that technical vocabulary problems are exceedingly complex, and an analytical approach essential. After preliminary work with a number of the groups, it was finally decided to make first intensive study of I and IV, elements and apparatus.

TABLE I.

Number of terms of various types in a list of the technical terms in high school chemistry

I.	Elements		86
	metals	65	
	non-metals	21	
II.	Compounds		293
	inorganic	171	
	organic	122	
III.	Mixtures and Indefinite substances	111	
	alloys	18	
	minerals	37	
	organic mixtures and substances	56	
IV.	Apparatus		53
	glass and clay	15	
	electrical	8	
	mechanical	30	
V.	Processes	101	101
VI.	States	70	70
VII.	Properties and Characteristics		193
	physical	79	
	chemical	82	
	general	32	
VIII.	Miscellaneous	125	125

FREQUENCY OF CERTAIN TERMS IN HIGH SCHOOL TEXTS

The next step taken was to count the frequency of occurrence of all elements and all apparatus mentioned in three very widely used texts; for the apparatus, the laboratory manuals were also included.[7] The count was in terms of number of pages on which each item appeared instead of the more usual total number of mentions, because the latter method makes possible excessive values for terms mentioned very frequently on a page or two, but of relatively slight general importance. Table II summarizes the results.

Certain differences between the texts are obvious. Thus text A mentions twice as many different pieces of apparatus

7 The texts studied were Brownlee, "Elementary Principles of Chemistry," Allyn and Bacon, 596 pp., 1926; Holmes and Mattern, "Elements of Chemistry," The Macmillan Company, 519 pp., 1927; McPherson and Henderson, "Chemistry and Its Uses," Ginn and Company, 460 pp., 1926. It should be added that they are here not listed in the order of treatment in the tables, to prevent ready identification and possible implied criticism of any particular book.

TABLE II.

Page-Frequency of Elements and of Apparatus in Three High School Chemistry Texts and (for Apparatus) Three Laboratory Manuals

Text	*Elements*			*Apparatus*					
				A		B		C	
	A	B	C	Text	Lab.	Text	Lab.	Text	Lab.
70 and over ...	4	4	3	..	2	..	3	..	..
60-69	1	1	1	..	1	..	..	..	1
50-59	1	3	4	..	..	..	..	..	..
40-49	2	3	1	..	1	..	1	..	1
30-39	3	4	4	1	3	..	1	..	1
20-29	6	5	6	2	5	..	11	..	2
10-19	14	14	10	9	10	8	4	4	9
9	3	..	1	1	2	1	4	1	1
8	2	1	2	1	1	2	1	1	2
7	1	2	1	5	8	2	..	..	3
6	2	1	3	7	5	9	3	3	2
5	2	2	3	7	3	5	1	4	1
4	6	6	2	8	6	5	..	10	2
3	4	5	6	15	6	5	5	4	5
2	4	10	2	13	10	8	7	10	12
1	11	17	12	41	13	25	16	19	12
Total	66	78	61	110	76	67	60	56	54
Median	9	5	8	3	5	3	6	2	2

as text C. In text B, 22% of the elements mentioned, and 37% of the apparatus, are referred to on only one page. For the most part the texts are rather surprisingly similar, however. Thus the correlation between page frequency of each element in Text A and Text B (the correlations are rendered somewhat artificially large by large proportion of 1-1 frequencies) is .97, and for texts B and C, .96. There is also decided agreement between texts as regards most important apparatus — though the large proportion of 1-1 frequencies here makes the calculation of a coefficient of correlation hardly legitimate.

Differences between the elements, and between the different pieces of apparatus, in importance as indicated by frequency, are, of course, great. An average of only 37 elements (54% of those elements mentioned) and 19 pieces of apparatus (23%) are mentioned in the texts on more than 5 pages; in the laboratory manuals an average of 29 pieces of apparatus (46%) are so mentioned. Oxygen is at the top of the list of the elements with an average mention, for the three texts, on 145 pages. Table III shows the 40 most frequently mentioned elements, with the average frequency per book, the relation to the Thorndike and Powers lists — and certain other data to be referred to later.

TABLE III.

The 40 most frequently mentioned elements; the number of pages on which each occurs, in each text, the Thorndike and Powers index number of each, and the percent of high school and of college students knowing the symbol for each

ELEMENT	Page Frequency Text				Index Numbers[8]		Test, % Correct	
	A	B	C	AV.	Th.	Po.	H. S.	Coll.[9]
Oxygen	158	155	122	145		1 a	100	100
Hydrogen	124	124	95	114		1 a	100	100
Iron	72	88	75	78	1 b		97	98
Chlorine	64	82	52	66		2 a	98	100
Carbon	75	50	67	64	5		96	100
Sulfur	48	57	56	54	8		90	98
Copper	45	61	51	52	2 b		98	100
Nitrogen	52	44	51	49		2 a	94	100
Sodium	38	52	42	44		2 a	98	100
Zinc	27	49	31	36	7		99	98
Silver	31	38	25	31	1 a 5		95	100
Phosphorus	31	31	29	30	5		78	100
Lead	20	38	33	30	1 a 5		74	100
Mercury	24	43	22	30	5 b		70	100
Aluminum	21	25	84	28		6 c	99	98
Potassium	23	33	20	26			94	98
Gold	25	22	25	24	1 A 4		49	94
Magnesium	18	22	30	23		3 a	92	98
Calcium	15	19	29	21		3 a	98	98
Helium	19	17	13	16		4 b	89	100
Tin	12	21	15	16	3 a		49	91
Platinum	16	15	14	15	3		54	80
Iodine	8	18	18	15	3		93	100
Silicon	16	13	14	14		4 b	82	97
Bromine	10	25	16	14		3 b	92	100
Nickel	15	17	8	13	4 b		58	64
Radium	10	19	9	13		3 b	80	83
Lithium	9	18	6	11		7 d	74	98
Argon	12	12	8	11		5 b	36	83
Chromium	10	10	10	10		4 c	64	87
Manganese	10	6	14	10		3 a	72	95
Arsenic	10	13	6	10		4 b	59	91
Fluorine	7	10	10	9			59	97
Antimony	9	11	6	9		5 b	37	77
Urassium	8	11	4	8		4 c	33	88
Cobalt	9	7	2	6		4 a	51	92
Neon	10	3	4	6		7 c	37	92
Barium	4	8	5	6		6 b	76	97
Tungsten	4	2	10	5		4 b	22	46
Boron	4	7	3	5		6 c	25	78

8 The Thorndike index numbers show directly for the most frequent 5,000 words, the position of each word in the list (thus 1 b means that iron is in the second 500 of the first thousand, while 1 a 5 indicates that silver is in the fifth hundred of the first 500). For the second 5,000 the index numbers indicate position in the list roughly as follows: 3, last thousand; 5, seventh thousand; 7, sixth thousand; 8, fifth thousand. The Powers index numbers indicate frequency as follows: 1 means that the term has a frequency of more than 500, 2 indicates frequency of 250-499, 3 from 100-249, 4 from 50 to 99, 5 from 30 to 49, 6 from 20 to 29, 7 from 10 to 19 and 8 indicates a frequency less than 10. The letters a, b, c, etc., indicate the range of occurrence, that is the number of sources in which the term was found; a means that the term was found in 5 sources, b in 4, c in 3, d in 2, and e in 1 source. Aluminum presumably should not have a Powers index number, since his list is supposed to include no terms in the Thorndike list.

9 The college data are here a combination of the two groups.

In contrast to the very frequently occurring items are the items occurring only once, in a text — the texts average 20% of the elements so mentioned, of those elements they do include, and 36% of the apparatus, and the laboratory manuals 22% for apparatus.

Of the 81 elements mentioned, 15 are in the Thorndike Word Book, four of them in the first thousand words in the language in frequency, and met by the average child in his reading from the first grade on; the remaining 66 are outside the most common ten thousand words in the language and rare in the reading of the average adult. And 35 more are included in the Powers list of important terms for the high school science. For the 35, the correlation between Powers and the writer's frequencies is .82. Of the 50 elements which the writer found most frequent, all but 5 (fluorine, glycinium, potassium, tellurian, vanadium) occur in either the Thorndike or Powers list and only 4 (cerium, iridium, molybdenum, titanium) in these latter lists are not included. In short, it is possible from the total of these data to obtain some evidence as to the elements most important for high school pupils to know — evidence as to those elements with which they may already be familiar — and evidence also suggesting that perhaps around 30 of the elements mentioned might possibly be omitted from texts intended to cover the minimum essentials, for secondary school youngsters. Of the 178 pieces of apparatus found by the writer in all his sources, 62 are not in the Thorndike or Powers lists[10] and 31 of the 62 occur in all six volumes a total of less than four pages. In short, here again there is evidence of possible reduction of detail, in current texts.

RESULTS OF CERTAIN TESTS ON ELEMENTS AND APPARATUS

The next step undertaken by the writer was the formulation of three very simple tests covering the most important material

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10 Since the writer listed Bunsen burner, deflagrating spoon, electric arc light, where Thorndike and Powers took only single words, certain of the 62 are probably simply a product of this difference in method — were found frequently at least in Powers' material, but were not listed as distinct from the constituent words—"burner," "electric," "light."

The pieces of apparatus (a term which was interpreted very broadly to include not only objects used in a laboratory but also objects, appliances, or machines mentioned in connection with the uses of chemistry) which were mentioned an average of ten or more times in text plus manual, were as follows: test tube, 92; bottle, 58; beaker, 53; tube, 38; Bunsen burner, 35; tube (glass), 33; tube (rubber), 31; evaporating dish, 30; flask, 27; ring stand, 21; stirring rod, 20; stopper, 19; gauze, 19; cylinder, 18; funnel, 17; wire, 16; watch glass, 15; vessel, 15; pneumatic trough, 14; glass plate, 14; clamp, 13; crucible, 13; generator, 12; graduate tube, 12; blow pipe, 11; electric furnace, 11; funnel tube, 11; glass rod, 10.

as determined by the analysis reported in the previous section. The first test simply listed, in order of frequency, the symbols for the 40 most frequently mentioned elements, and required that the student write after each symbol the name of the element for which it stood.

The second test, on uses and occurrences of these same elements, contained material such as the following, the student being required to write after each statement the element to which that statement referred.

> The element that composes two-thirds of the weight of the human body .....
> The most extensively used metal .....
> The element that is a very combustible explosive gas .....

The purpose was to determine whether the student knew certain important facts about the elements; the material was not in many respects as satisfactory as might be, but as will be seen later, served some purpose in connection with the writer's general undertaking.

The third test, on apparatus, consisted again of forty items such as the following, the student in each case being asked to write after the statement the name of the apparatus referred to:

> Used for measuring the pressure of the atmosphere .....
> Used for concentrating a solution by expelling the moisture .....
> A glass covering for an evaporating dish .....

As will be obvious, the purpose of the test was to see whether the student knew what these pieces of apparatus were used for, so that if he wanted to do a particular thing he would know for what to ask. The 40 questions deal with items selected by the writer on the basis of all the information available to him as frequently mentioned, appearing in all three books, not so well known in everyday life as to constitute no problem (thus "bottle" hardly needed to be included in the test) and somewhat distinctive of laboratory work. Again certain items of the test were either too easy or otherwise unsatisfactorily formulated — but again the general run of the findings seemed not without value.

These tests were given to a total of three hundred high school students taking elementary chemistry and to two groups of college students, one of which had had high school chemistry and was now taking a second course in college chemistry, while the second college group was taking college chemistry but had

had no work in the subject in secondary school. And these data were supplemented by results from four small groups of college students who were not now taking chemistry. The students in the first of these had had no chemistry, either in high school or college, while the second group had taken only high school chemistry, the third only college chemistry, and the last both high school and college chemistry. Table IV shows the general run of the results, while the last two columns of Table III give some data by item on the symbols test.

TABLE IV.

Distribution Table: Scores on Chemistry Vocabulary Tests[11]

Group: Amt. Chem. Score	El: Symbols H. S. H. S.	N	H	College C	B	O	P	El: Uses & Occ. H. S. H. S.	College C	B	Apparatus H. S. H. S.	Coll. Both
39-40	22	..	..	20	5	1	4	..	..	2	..	..
37-38	26	..	..	14	8	3	1	3	..	..	2	2
35-36	21	..	..	2	12	2	1	3	..	1	3	1
33-34	32	..	1	1	8	4	2	5	1	4	5	7
31-32	26	..	1	..	..	2	..	5	1	6	0	7
29-30	36	..	3	..	..	..	1	4	2	4	12	5
27-28	31	..	..	..	1	1	2	12	2	3	12	2
25-26	43	..	1	..	..	2	..	11	3	7	21	2
23-24	23	..	3	..	..	3	2	25	8	2	24	3
21-22	20	..	1	..	..	3	..	27	5	2	19	3
19-20	12	..	4	..	..	1	..	36	7	1	13	..
17-18	5	1	7	..	..	1	..	40	2	1	11	..
15-16	2	..	4	..	..	..	..	39	2	1	12	..
13-14	..	..	3	..	..	..	..	28	3	..	6	..
11-12	1	1	1	..	..	..	..	28	..	..	3	..
9-10	..	3	4	..	..	1	..	23	..	..	1	..
7-8	..	5	1	..	..	..	..	10	..	..	..	..
5-6	..	9	1	..	..	..	..	4	..	..	..	..
3-4	..	10	3	..	..	..	..	..	..	..	..	..
1-2	..	3	1	..	..	..	..	..	..	..	..	..
Total	300	32	39	37	34	24	13	303	36	34	153	32
Median	29	5	17	39	36	30	34	17	22	28	24	31

As will be seen, the high school students are distinctly unfamiliar with the symbols for many of the important elements. Even in college the situation is not as satisfactory

11 The high school students were tested when they were about three-fourths of the way through a year course in chemistry. Of the college students the first group tested (N) had had no chemistry, the second (H) chemistry in high school but not in college, the third (C) had almost completed the first year of college chemistry, but had had no high school work in the subject, while the fourth (B) had nearly finished a first college course, but had had the subject also in high school. The last two groups were not now taking chemistry, but at some previous time had had college chemistry only (O), or both high school and college chemistry (P).

For the Uses and Occurrences test, the medians for the distributions not included are as follows: Group N 5, H 10, O 17, P 25.

as might be expected. Although, as already mentioned, the second and third tests are not all they might be, the distinctly low score of the high school students when they were asked regarding practical use or significance of an element is worth noting. It is interesting that the college students who have never had any chemistry, have five symbols correctly identified, and five answers correct on the uses and occurrences test. Thus 100% of this group knows that O stood for oxygen; other symbols correctly identified by 30% or more of the group were H (97), N (69), d (34), C (34), S (31), Mg (31). But this is of course to be expected; common sense plus everyday reading, advertisements for tooth paste, and what not, give passing familiarity. More surprising is the considerable loss shown by those students whose chemistry is a matter of past history. Not that they should be expected to remember all such detail two or three years after a course has been taken. But still that these students who had a year course in high school chemistry can identify the symbols of only 17 of the 40 elements mentioned most frequently in high school texts is of some interest. . . . However, the number of cases is small, and the results not to be stressed.

Certain correlations are of interest. Thus, correlation of score on the symbols test with score on the uses test for high school students was .90 (the correlation for the college groups could hardly profitably be made because of the small number of cases and the asymmetrical distribution of scores on the symbols test). Correlation for the high school group between score on the symbol test and total frequency of mention of elements in all the texts was .70. Similar correlation for the uses and occurrences test was .54, while for the apparatus the correlation was .33. On apparatus the frequency of use in the laboratory might be expected especially to introduce a a variable, beyond frequency of presentation in the texts, which would lower the correlations. But in general these findings seem to suggest distinctly (a) that knowledge of factual material (as symbols) may after all be rather closely related to knowledge less mechanical in character, and (b) that frequency of mention in texts is of some significance in relation to the extent to which a student becomes familiar with that item in the course of his study of the subject.

DISCUSSION

Doubtless to the teacher of chemistry such routine and clerical research may seem of little value. But surely in chemistry as well as education, painstaking routine research is often needed. The text book and laboratory manual are (to use a biochemical analogy) the chief substance to which the student reacts, and it would thus seem important that this substance be carefully described as regards its composition as a series of stimuli. At least the results may lead the chemistry teacher to congratulate himself when comparisons are made with certain other subjects. Thus, it has been found that text books in history may present close to a thousand different characters — it is a bit as though a whole regiment were marched before the bewildered student and he was told the name and one or more facts about each man. The findings suggest (though of course the writer catalogued only certain types of items) that in chemistry the situation was not quite so diffuse. But the findings suggest also that a more clear marking out of the more important materials, and a stress upon these, might result in more effective learning. The correlation between tests and frequency of mention is again to be called to mind here.

And as to the value of the tests? Certain findings of a general significance have already been mentioned. The writer wishes only to point out that such tests, considered item by item, can be of great value to a teacher who might desire to assure himself that his students had a minimal equipment of factual knowledge necessary for progress in his work. The tests used by the writer were designed primarily for his special investigation and are hardly suitable for general use. But objective tests of this general type, covering carefully selected material, can be of great service.[12]

12 The writer's work included an attempt which will doubtless seem to most readers bizarre, to give drill on factual material by means of a drill machine. The apparatus used has been described elsewhere (Pressey, S. L. "A Simple Apparatus Which Gives and Scores Tests—and Teaches," "School and Society," Vol. 23, pp. 373-76, 1926). The findings, though somewhat indeterminate, indicate that the idea may not be so absurd as might appear. Further work is being done on the subject, with an improved mechanism, by others.

SUMMARY

1. The paper reports an attempt to study intensively certain problems of vocabulary and related information in high school chemistry.

2. The technical terms in the subject, as previously determined, were first investigated as to their relation to general vocabulary and technical vocabularies in other fields, and were systematically classified.

3. Mentions of elements and apparatus were then intensively investigated, page frequencies for such items being counted in three widely used texts, and the relationships between the texts noted.

4. Tests on the most frequently mentioned items were then constructed and given to various high school and college groups who had not taken, were taking, or had previously studied chemistry. And various comparisons both between the test results and with the frequency counts, were made.

5. Certain general implications of the results are pointed out.

Air Pilots Should Know Elements of Meteorology

W. J. Humphreys, of the Weather Bureau, says: "Each aviator needs at least enough meteorology to enable him to read a weather map; enough to enable him to discuss the map intelligibly with the forecaster; enough to judge while in the air whether the forecasts are coming true; and enough so that he understands the weather significance of the clouds and the look of the sky.

"From his study of meteorology, with the aid of the forecaster, and of the latest weather map constructed from extremely recent observations along and on either side of his route, the aviator learns what sort of weather to expect. Since weather does not always come exactly according to forecast, it is essential that he know what kind of weather he probably will encounter, and he must definitely understand the significance of clouds and other weather appearances. He must know to a certainty, from the looks of things, whether the expected storm is developing sooner than anticipated, or later"

Benefits Derived from a General Science Demonstration File

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Do you need more time for work in the laboratory of your general science courses? Do you have time to find the material needed? Do you give your demonstrations in the best possible way? These are a few of the questions which confront the conscientious progressive science teacher.

The laboratory or demonstration is one of the most important factors in the general science course. Very little is gained from general science as a textbook-recitation course. Pupils should do most of the work themselves if they are to receive the maximum value. Junior high school pupils are at the age where they want to see, inquire, and act. The class period may consist of reports on special projects, organization of facts, reading, observations, laboratory exercises, construction, field excursions, demonstrations, written or oral tests.

Demonstration in a class does a great deal to arouse interest, gain attention, and stimulate a desire to know and to do. Simple demonstrations usually furnish better training and more knowledge than difficult and complex ones. Simple home-made apparatus made by the pupils often gives better results than expensive and complicated laboratory apparatus. Our home-made ventilating box, made from a wooden box with a sliding glass front and holes closed with corks, shows the principles involved in ventilation better than any purchased apparatus that we have been able to find. All important or difficult demonstrations should be tried out before the class period.

By a demonstration is meant, a class display or illustration used as a means of giving proof or developing a course of reasoning showing that a certain result is a necessary consequence of assumed premises. Demonstrations may be used to raise problems, illustrate ideas, review topics, answer questions or test the pupils for knowledge. Original demonstrations by the pupils should be encouraged. There are two kinds of demonstrations: the teacher demonstration and the pupil demonstration, or there may be a combination of the two.

In the teacher demonstration, the teacher does all of the

illustrating or performing while the pupils watch without helping or contributing in any way. The teacher should perform the demonstrations that require experience or training in handling the apparatus or materials. Phosphorus and concentrated acids may be dangerous for pupils to handle at the beginning of the science course and to decompose water by electricity, using the electrolysis apparatus, is far too difficult for a science beginner, although that demonstration is placed early in the course in some science books.

In the pupil demonstration, the pupil does the illustrating or performing and the teacher stays in the background. It is desirable to have as much pupil activity as possible. Pupils may cooperate in setting up apparatus and in performing the demonstrations or one pupil may do the demonstrating by himself.

I have been able to make my work more efficient at Central Junior High School by the means of a "Science Demonstration File." The "Science Demonstration File" was not an original idea with me. It developed through a suggestion made by Dr. Ralph K. Watkins of the University of Missouri. Before beginning to make the science demonstration file, a survey was made of all the general science books available. The general science course of study based on the adopted text[1] was taken as a core or basis around which to work. A list of demonstrations was made from this course of study. Each of the demonstrations listed was typed, or cut and pasted, on a 4x6 filing card. Many of the laboratory manuals that are printed only on one side may easily be cut to fit a 4x6 card, which will save time in typing and drawing.

At the top of each card was placed the general topic, the name of the particular demonstration, also the reference index number.

SAMPLE CARD[2]

Foods. *To Test Foods For Sugar.* Ref. 4
Directions:
Part I. What is the test for sugar?
Place small amounts of grape sugar, salt, cornstarch, egg-white, and lard in test-tubes. Add a little Fehlings' Solution. Heat gently. Observe all changes until the substances have each boiled two minutes. Allow the test tubes to stand a few minutes.
In which do you find a brick-red powder?
Describe the test for sugar.

1 The text used in Kansas City, Kansas, is the Science of Everyday Life, by Van Buskirk and Smith.

Part 2. Testing foods. (Each pupil should test at least one kind of food.)

Grind up the seeds to be tested, and place them in separate test-tubes. Use small quantities of other foods. Add Fehlings' solution and boil. Watch for the orange or brick-red color.

Question: Is the brick-red powder sugar?

"Ref. 4" refers to the index number on the list of science books which contains the name of the book, date of publication, the author, and the name and address of the publisher.

Each of the other science books or laboratory manuals was taken in order and cards made for demonstrations that were related or had a bearing on the course of study. The completed cards were classified according to subject headings and filed alphabetically. In several cases as many as six different demonstrations were found for the same principle or topic. At the end of one semester's work four hundred twenty-one demonstrations had been classified and filed alphabetically. Some of them were very similar but with enough difference that it was thought advisable to have them on file.

Empty chalk boxes, stained brown by some of the boys in a woodworking class serve nicely as filing cases. The 4x6 filing cards and index cards may be purchased at any bookstore.

A science demonstration file is distinctive or useful, not only by virtue of what it contains, but also by virtue of what it leaves out. Demonstrations too technical, stupid, dangerous, or difficult of manipulation should not be included.

The science demonstration file may be used in many helpful ways. It often happens that certain pupils do not clearly recognize the problem or observe the facts when they are presented. Further demonstrations and repetition of demonstrations are demanded until all have reached an agreement concerning the facts explained or illustrated. There can be no scientific thinking until the problem is recognized. The chief value of the demonstration consists in the fact that it has a well-defined purpose, that it seems to the pupils quite worth while or a vital problem, and that it serves in making clear the solution or answer to that problem. This to some extent will determine which of the demonstrations is to be used in your classes. A well-worked-out science demonstration file will give a number of demonstrations from which to select.

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2 The sample demonstration is from Van Buskirk and Smith.

There will be a demonstration for each type of class and the concrete materials and examples will help to fasten theory and facts in the minds of the pupils. As there are many ways of demonstrating some problems and as there is a variance in laboratory equipment, different experiments on the same problem may be carried out.

Professor W. L. Eikenberry in *The Teaching of General Science* says, "It is very common to find that in practice the laboratory work is slighted or is even omitted entirely." With a "Science Demonstration File" at hand this tendency should be lessened. Many science teachers would like to have more demonstration work but find their time is limited because many have more than one subject to teach. They are at a loss, just where to find the right demonstration at the right time, so that they let the opportunity pass, thinking that they will come back to that particular phase of the work in a day or two when they have had time to find the right demonstration, with the result that they neglect to find the right one or by the time it is found the pupils' point of interest is elsewhere.

Another use of the "Science Demonstration File" is to eliminate waste of time in the preparation of the lesson, both by the teacher and by the pupils in the class period. Two or more cards may be given out to a pupil group at one time, the materials for the demonstrations may be secured from the storeroom and the apparatus may be set up for several closely-related demonstrations on the same day. For example, all the demonstrations on pulleys may be given and the comparison made between fixed and movable pulleys. Or, in showing the effects of heat, the ball-and-ring apparatus, the metal compound bar, a thermostat, or a conductometer may be demonstrated.

There may be one or two pupils in the class with a scientific turn of mind that are especially interested in a given subject and they may want to carry the work farther than time or interest would permit for the whole class. These pupils may be given cards from the "Demonstration File" to continue work more extensively for themselves, while the other members of the class are preparing the next day's assignment or working on problems of interest to themselves from the text or reference library.

A good "Science Demonstration File" is not made in a day, week, month, or year but like a good reference library it grows as the time passes. Its uses and possibilities also grow.

Organizing the Biology Class Into a Nature Study Club[1]

ETHEL BUSH
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In this age, when the world seems to have become unusually "Nature conscious," Biology should be a most teachable subject. Because it is so varied in its application, it is a source of inspiration to a teacher,—a subject ever new and more wonderful in itself and in its meaning to the pupils. It is fascinating to the pupils because it helps them understand something of that most interesting and yet most mysterious of all subjects—Life. It gives them a peep behind the curtain of Nature's marvelous workshop. And with an understanding of some of the principles and forces by which this shop is governed, there comes an appreciation of the eternal fitness of things. The pupil realizes that while the saying is true, that there is nothing constant but change—that these changes follow certain rules. He learns that every action is followed by a definite result, and that when we conform to Nature's laws we attain satisfaction and that disregard for them brings disappointment. The student begins to see himself as a part of this great scheme, with certain powers and privileges and consequently certain duties and responsibilities.

Biology satisfies a student in that it helps him find his place and feel at home in our world. This is a big step in education and fortunate indeed is the person, usually known as a teacher, who has the privilege of studying nature with a class of boys and girls. But no one has a right to such a place who is not first, heartily in earnest about helping those students, and second, wholly enthusiastic about the subject.

When a college freshman, who had shown unusual interest in the study of Biology while in High School, was asked to define his ideal class, his reply was: "We would like a friendly understanding teacher who in a sensible (scientific) way would help us find answers to the thousand and one questions that arise in our minds about this world in which we live." In other words, we are to remember that no matter how much we know or how many degrees we have acquired, we are

1 Paper presented before Science Section of the Alabama Education Association.

teachers of pupils—not subjects. Our main business is helping pupils "tune in."

If we would take this pupil's suggestion, our first aim is to form a partnership with the class,—to make them feel that it is our work, our laboratory problem and equipment, and that the recitation is our discussion group. Therefore, each member is to contribute something if he is to enjoy the friendship, co-operation and respect of the other members of the group. In the belief that the ordinary type of recitation often fails to bring about a sense of partnership and individual responsibility on the part of the pupil, the author has used the classroom procedure described below as a means of securing these seemingly desirable ends. This plan has been in operation for five years at the Phillips High School and the results have been much better than the old recitation-textbook plan, if one can judge by pupil reaction, enthusiasm and achievement.

In order to get acquainted, to find out which are the outstanding students, the ones who would make the best leaders and what the special interests of the class are, we have informal discussions once a week. These discussions are based on parallel reading from some scientific book or magazine, and one study period each week is reserved for this outside reading. After a pupil has given his oral report, the class may discuss the topic from the standpoint of the principles we have been studying in our textbook or have been working out in the laboratory. Of course, it is impossible for every pupil to give a report once a week, so those who do not recite hand in notes and are given full credit.

At first no effort is made to unify these discussions, but later special emphasis is placed on some topic of local or immediate interest. During the Mississippi Flood the class in plant biology was especially interested in the relation between forest conservation and floods. Another class studied the health problems that would arise from such a situation: sanitation, epidemics, mosquito extermination, and food and nutrition. Once we learned about insects through the problem of exterminating Argentine Ants from our city. Other local topics studied are: The Mediterranean Fruit Fly, Tent Caterpillars, Our Insectivorous Birds, Tree Conservation, Living Christmas Trees, Our Milk Supply, Preparation of Certified Milk. And since we have had an unusually heavy snow this winter, we have had

a new topic: the effect of snows and freezing on soil, on plant growth, and on the extermination of insects.

After the pupils have become acquainted, the class is organized as a nature club, with the usual officers: president, vice-president and secretary elected by secret ballot. The president conducts the formal meetings held once each month, takes charge of the class if the teacher is detained for a part of a class period, appoints all committees and a critic for each program. A committee of four is selected to assist the vice-president in planning programs for the term. Each member chooses a fourth of the remaining members of the class, just as in selecting sides for the old-time spelling match, they draw numbers for their dates for programs, and the class organization is complete.

After this each team begins making plans, which are submitted to the vice-president, whose duty it is to see that the topics do not overlap. So our year book is made and each group sets to work enthusiastically to prepare the best speeches and get the most interesting demonstration material. Here is a very satisfactory demonstration of group loyalty, friendly rivalry and true sportsmanship. Not one pupil in a hundred fails to make a contribution. In cases of illness the students send their papers for another member of the class to present.

These meetings, held at the regular class period, are absolutely formal, being conducted according to Roberts' Rules. In one class the question arose as to whether the Bible should be read as it is in our literary clubs. In the discussion which followed it was agreed that this would be desirable if the secretary would carefully select a passage related to the topic for the day and read it reverently. They did not favor the reading just as a matter of routine or as an afterthought.

Though the topics are presented orally, the papers are written to be handed in, and the best ones are filed so that they become a part of our reference material.

Sometimes we borrow demonstration material which must be returned, but most of it is collected by the students, preserved, mounted, organized and labeled for our permanent museum material. Often these exhibits are accumulations of material brought by several students. From such collections we have arranged:

An outfit for keeping cocoons, killing, drying and mounting insects.

A collection of shells, corals and sponges.

Industrial exhibits of cotton, rubber, paper, cork, turpentine, corn, rayon, flax, silk, cocoa, tobacco, and a collection of food products showing the use of common substitutes and adulterants.

One group of students has arranged a balanced aquarium, another a miniature desert, and still another has a table with growing plants showing the succession from bacteria to flowering plans. The zinc boxes used for the last two collections were made in our manual training shop. The plants were collected on field trips. One student has made a book of the trees of Birmingham, using kodak pictures for illustrations. Another has done a similar piece of work, illustrating it with blue prints of the leaves.

Some of this individual work is done during the laboratory periods, but most of it is done at home or after school. The laboratory, in which the class spends two periods two days each week (four periods in all), is a real workshop. The work is planned on the basis of what the average pupil can accomplish. Then the exceptional students who finish before the allotted time, and the repeaters who have gained some working knowledge, are used as laboratory assistants. They set up simple demonstrations, such as food tests, transpiration and germinating tests. They care for window boxes, keep the exhibit cases and laboratory material in order, operate the picture machine and file the films or slides. Being relieved of these mechanical details the teacher has time for checking notebooks and discussing the mistakes and difficulties with the individual student. This is also a time for finding out more about the pupil's special interests, for offering suggestions about programs, or any problems that he may have. Some laboratory periods are spent in the city park, where we have learned the names of the trees and shrubs.

Pupils are encouraged to bring any kind of specimens they may find, and these vary all the way from pond scum to snakes. One student even borrowed a pet monkey, which she kept at school for a day. If we obtain more material than we can use, the best of it is shared with some of the elementary schools or even with the neighboring college.

This collecting naturally leads to an interest in field trips. At first these are rather informal,—the teacher going on expeditions after school with just a few volunteers. If the trip is to a mill, factory, dairy, or similar place, the members of the party give their classes detailed reports on which they take notes. If the trip is a ramble in the woods, we have discussion of the materials collected. It seems more profitable in the long run to take small groups of ten or fifteen than to attempt to take an entire class at any one time. Only twice during the term is the entire class required to go on a field trip together. In these cases the teacher visits the locality before the day set for the pupils to go and gives an outline for special study. The day following the trip, short reports are given on certain items and sometimes we have a contest in identifying specimens. At other times the pupils write lists of questions to ask each other.

Collecting algae and minnows on one of our field trips. A seventh semester biology class studying types of trees.

Two days of each week are given to the usual formal recitation and outlines are made for the work covered. But the general practice is to bring as much of the outside world as is possible into the classroom, use the textbook for reference purposes only, and let Nature be the teacher, hoping that she will guide modern youth as she did the young Agassiz, when:

"She sang to him night and day,
The rhymes of the universe;
And whenever the way seemed long
Or his heart began to fail,
She would sing a more wonderful song,
Or tell a more marvellous tale."

The following three special weekly programs were presented during the present year:

SPECIAL PROGRAM: "OUR STATE"

1. Psalm 67.
2. Natural Divisions of Alabama.
3. Grains.
4. Cotton.
5. Turpentine and Naval Stores.
6. Fruits.
7. Fish and Game.
8. Critic's Report.

The above program was written with red ink on an outline map of Alabama and one copy provided for each pupil.

A VISIT WITH NEPTUNE

1. Scripture: Genesis, 1st chapter.
2. Geography of the Sea.
3. Peculiar Sea Plants.
4. Curious Fish.
5. Sponge Gardens.
6. Coral Beds.
7. Oysters and Pearl Diving.
8. Critic's Report.

REPTILES

1. Roll call answered with Superstitions about Snakes.
2. Ancient and Prehistoric Reptiles.
3. Poisonous Reptiles of the United States.
4. Economic Importance of Reptiles.
5. Preparation of Anti-Venum Serums.
6. Critic's Report.

Interest as a Factor in Achievement in Science*

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Considerable has been said and written concerning general mental ability as a factor determining achievement. Quite high correlations have been obtained between achievement as measured by objective tests and intelligence, in classes in the teaching of physics. For the school year 1922-23, for example, the obtained coefficients in my own classes were .68 $\pm$ .03; for 1923-24, .64 $\pm$ .03; for 1924-25, .77 $\pm$ .03; and for 1925-26, .66 $\pm$ .04. These are higher than those commonly reported but they substantiate one another. That the objective tests mentioned are intelligence tests is disproven by low correlations obtained between the same tests and intelligence scores, with students enrolling in certain college classes in physics. These correlations are in the neighborhood of .20.

It has become clear, however, that within a group fairly homogeneous with respect to general mental ability, great ranges in achievement are common. It is obvious that there are other vital factors determining achievement. In studies of factors determining achievement, interest should receive considerable attention. Probably no one would dispute the statement, that given a degree of general mental ability, achievement is increased if interest is present. Perhaps some would minimize the importance of natural interest, however, and contend that applied effort, although unaccompanied by natural interest, will result in superior achievement.

It is the province of research to collect facts bearing upon questions suggested by these statements, and this paper is a report of some factual data already collected. They were gathered in the pursuance of three separate and distinct studies. The first was a study of prognostic testing for college courses in mechanics during 1928-29; the second was a study of determinants of achievement in a college course in electricity and magnetism in the spring of 1929; the third was a case study of pupil factors determining achievement in high school physics in 1924-25.

* Presented at meeting of National Association for Research in Science Teaching, Atlantic City, February, 1930.

The tables are self-explanatory and the discussion will, therefore, be limited.

Table I shows relationships between mean scores in a test in high school physics given to students enrolling in a course in college physics at the University of Minnesota in the school year 1928-29, and expressions of subject interest in high school. Table II similarly shows relationships between the same expressions of interest and mean final grades received in the college course.

TABLE I. *Distribution of Scores in Preliminary Test for Those Expressing Major Interests in High School*

Major Interest	FALL			WINTER			SPRING		
	Mean	*S. D.*	*Cases*	*Mean*	*S. D.*	*Cases*	*Mean*	*S. D.*	*Cases*
Science	44.06	19.2	48	35.29	11.8	24	36.79	20.2	14
Science with other subjects ..	41.14	19.8	188	39.20	17.3	77	35.68	18.6	66
Mathematics	25.74	18.2	43	34.61	18.1	19	17.50	19.1	6
One field other than science or mathematics	20.53	12.2	38	27.50	12.9	19	33.20	16.7	14
Two or more subjects	21.89	16.4	58	25.45	12.34	27	22.30	15.10	25

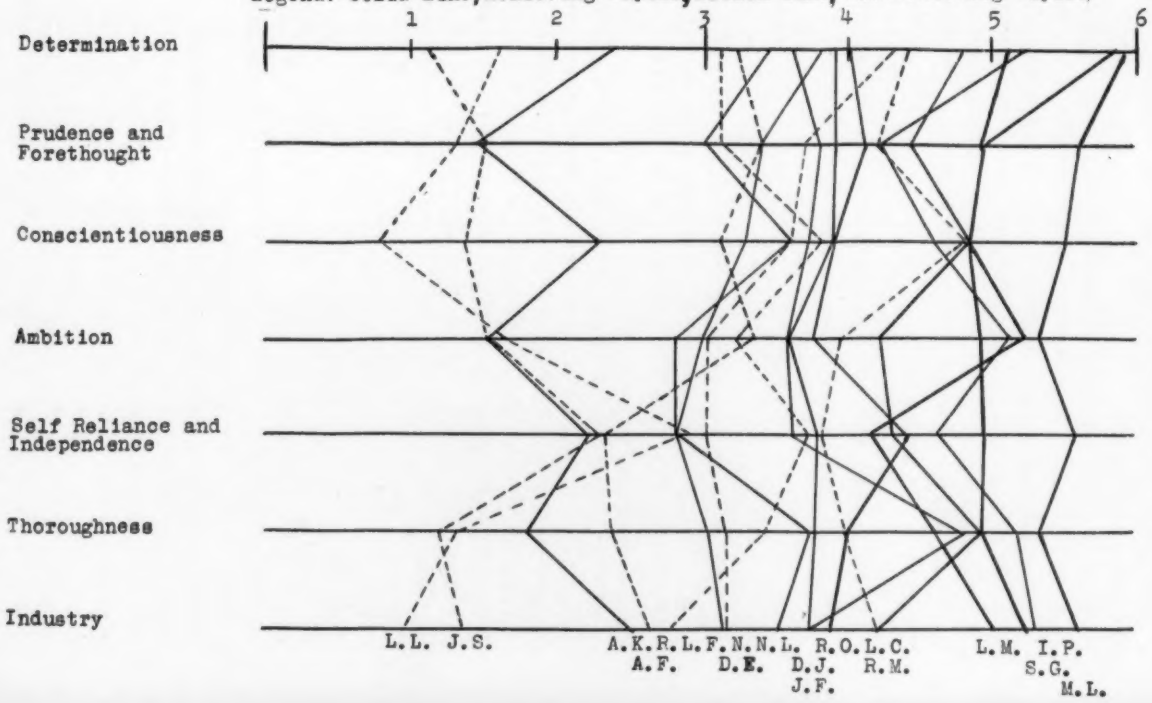
TABLE II. *Distribution of Final Grades in Mechanics for Those Expressing Major Interests in High School*

Major Interest	*Mean*	FALL *S. D.*	*Cases*	WINTER *Mean*	*S. D.*	*Cases*
Science	65.92	14.23	35	73.65	10.01	20
Science with other subjects..	68.56	14.80	141	71.24	11.60	81
Mathematics	66.72	16.26	32	78.50	9.53	15
One field other than science or mathematics	62.90	13.18	25	65.78	6.58	14
Two or more subjects	64.17	15.18	36	71.00	11.67	18

Table III bears upon numbers of science courses taken in high school which probably reflect interest in science. The table shows relationships between these numbers of science courses and (1) scores in a test (Test X in the table) covering elementary electricity and magnetism, given preliminary to a course in the University in the same field in 1928-29; and (2) final grades received in college courses in heat, mechanics, and electricity and magnetism, respectively.

FIGURE I
AVERAGE TRAIT RATINGS TO COMPARE ACHIEVING AND NON-ACHIEVING PUPILS

Legend:-Solid Line, Achieving Pupils; Broken Line, Non-Achieving Pupils



S.C. M.L. R.M. D.J. J.F. D.E. A.F.

These tables give evidence in support of the following conclusions:

(1) Those expressing major interest in high school science alone or in combination, when enrolling for a course in college physics (mechanics) at the University of Minnesota, have, on the average, much higher scores in a preliminary test covering the field of high school physics.

(2) Those expressing interest in high school science alone or in combination, when enrolling for a course in college physics (mechanics) at the University of Minnesota, do not make, on the average, any higher grades in the college course.

(3) The number of sciences taken in high school has a definite relation to the scores made in a preliminary test in elementary electricity and magnetism, by students enrolling in a college course in electricity and magnetism at the University of Minnesota.

(4) The number of sciences taken in high school bears little relation to grades made in the college courses in mechanics, heat, or electricity and magnetism.

Table IV and Figure I refer to case studies of high school pupils in 1924-25. During the preceding year 1923-24, two mental tests and ten objective tests in physics were given to all pupils. Ratings in both the mental tests and the subject matter tests were reduced to sigma units on the assumption that such abilities are distributed according to the normal curve. These sigma unit ratings ranged roughly from 20 to 80, with the mean at 50. A person receiving 40, for example, was one sigma unit below the mean. Similarly, one receiving 60, was one sigma unit above the mean.

From the total group, all students who differed in mental ability and achievement by an amount equal to, or more than, one sigma unit were selected as cases for individual study. For example, if the mental ability rating was 65 and the achievement rating 55 or less, the student was included. In the total group, there were found 17 cases who had discrepancies in one or the other rating by at least one sigma unit. Of these 17, 6 were lower in achievement than in mental ability, and 11 were higher. In other words, 6 were achieving on a level much below expectation, while 11 were achieving on a level much higher than expectation. During the next school year, case studies were made of each of these individuals by

means of interest blanks, health blanks, environmental blanks, and individual conferences. The object was, as stated before, to discover if there were outstanding factors which would explain the superior or inferior achievement.

Time precludes an extended discussion of any individual case. Needless to say, every case was very interesting and served to direct attention to the wisdom of paying attention to the individual, if instruction is to result in maximum benefits for all.

Only the more objective phases of the study will be given here. Several of the statements touch upon interest. It might be well to say that these were usually expressed interests involving the terms (1) like very much, (2) like quite well, (3) neither like nor dislike, (4) rather dislike, and (5) dislike very much. This constitutes a five-point scale.

Another phase needing some explanation concerns the trait ratings. Six-point trait scales, having definitions at the lower and higher ends, with five intermediate designations were used for the following traits: determination, prudence and forethought, conscientiousness, ambition, self-reliance and independence, thoroughness, and industry. These were given to four former teachers of each pupil, and the ratings obtained averaged for each trait and for all traits.

With these preliminary statements, Table IV and Figure I should be understandable. Those called achievers are the 11 referred to above. The non-achievers are the 6 who did not come up to expectations.

Two factors are strongly indicated from the data given, viz., traits and interests. That is, those achieving in physics express interest in it and in activities apparently conducive to satisfactory achievement. It is significant that 100% of the non-achievers generally complain more about their health. It suggests that there may be sound underlying reasons for these complaints, though we do not always sympathize with complainers. These factors suggest more general terms which may be useful in speaking of the characteristics of achieving pupils, viz., "drive," or motive"; or better still "drive enhanced by motive or incentive."

Certainly those pupils who achieved exhibited more of a "drive" or application than those not achieving. This driving force showed itself in interest, either intrinsic or derived, and

TABLE III. *Means and Standard Deviations of Certain Ratings in Physics for Students Having Taken Various Numbers of High School Science Courses*

	Number of Sciences in High School						
Ratings	*One*	*Two*	*Three*	*Four*	*More than Four*	*None*	*All Students*
Test X:							
Mean	16.44	19.47	19.20	21.46	24.16	14.75	19.04
S. D.	9.06	7.51	7.89	8.42	6.62	8.10	8.07
Cases	46	142	77	29	11	16	323
Heat:							
Mean	80.75	78.29	79.29	81.37	82.00	79.84	79.20
S. D.	10.35	8.01	6.90	6.78	9.99	6.69	8.40
Cases	12	82	42	16	9	9	166
Mechanics:							
Mean	68.40	69.42	71.26	71.09	69.20	67.75	69.51
S. D.	10.23	9.45	9.21	9.63	9.42	7.49	9.81
Cases	41	121	68	22	10	12	275
Electricity and Magnetism:							
Mean	71.53	67.44	69.36	69.66	71.20	70.50	68.97
S. D.	9.39	12.31	11.02	10.53	10.26	10.29	11.49
Cases	31	86	55	19	9	11	205

TABLE IV. *Comparisons of Achievers and Non-achievers in Various Possible Determinants of Achievement*

Criterion	*Non-Achievers*	*Achievers*
1. Mental ability (Sigma units)	56.3	46.4
2. Intelligence Quotient (Average of two)	118	112
3. Information tests in Physics I (objective)	62%	82%
4. Problem tests in Physics I (objective)	33%	56%
5. Marks in mathematics (A = 4, F = 0)	1.92	2.95
6. Total Scholarship (A = 4, F = 2)	2.04	2.84
7. Average achievement quotient	.74	1.33
8. Per cent Jewish	33%	55%
9. Per cent girls	50%	9%
10. Expressed interest in physics (Scale of 5)	3	1.4
11. Number of parties in a week	3.7	1.5
12. Per cent having lessons outside of school (Music, Art, etc.)	66%	73%
13. Expressed liking for study (Scale of 5)	3.16	2.90
14. Per cent working outside of school	84%	64%
15. General reading choice (Scale of 5)	1.1	1.8
16. Number of clubs and teams	3.3	2.7
17. Hours of recreation per day	3.1	2.7
18. Per cent having a hobby of some sort	33%	27%
19. Per cent having a favorable home environment	66%	64%
20. Number of brothers and sisters	1.5	1.5
21. Hours of sleep per day	8.1	8.1
22. Hours of work at home to help parents	.58	.66
23. Per cent complaining of health	100%	27%
24. Per cent having a definite aim	33%	55%
25. Average trait ratings (six point scale)	2.8	4.1

in exhibitions of those qualities which naturally receive high ratings in determination, thoroughness, industry, ambition, and the like.

Tastes for intellectual food certainly exist as do tastes for physical foods. Highly intellectual minds are interested in certain kinds of activity and disinterested in others. The reasons for a choice are difficult of explanation and due to varieties of causes. Thorndike's suggestion that certain reactions are repeated because of satisfaction which ensues, is enlightening in this connection. Satisfaction tends toward repetition; dissatisfaction, a discontinuation. From this viewpoint, dissatisfaction probably prevented the non-achieving pupils from spending more time on applied effort, thus preventing achievement, although mental ability existed. Even applied effort coupled with no responsive feeling of satisfaction may result in non-achievement.

A final paragraph may sum up the truths suggested by these studies. First, achievement is due to the release of the potential energy which we call general mental ability. Second, this release is accomplished, partly at least, because of interest, and results in a driving force showing itself in concentrated application. Third, if satisfaction ensues, the action of this driving force is continued.

The real teacher wishes to help his pupils to success when they might otherwise fail. The study of the pupil and his individual needs, together with the adaptation of the work to fit his particular personality, makes of teaching a profession instead of a trade. It induces the teacher to see situations with the eyes of the pupil and give advice tempered with the wisdom of an understanding and sympathetic mind.

Abstracts

GENERAL EDUCATION

What Training Do Beginning Teachers Need? G. P. CAHOON. University of California High School Journal, X: 131-159, August, 1930. A follow-up study of former student teachers shows in summarized form the answers to such questions as: (1) How does the success of the teacher compare with his success in practice teaching? (2) To what extent do teachers teach the subjects and grades in which they were trained as student teachers? (3) What are the problems which teachers find most difficult and for which they need most training? (4) From the standpoint of the usefulness to beginning teachers, what are the most valuable and what the least valuable features of the present teacher training program?—C. J. P.

A Tabulation and Analysis Sheet for New Type Tests. G. P. CAHOON. University of California High School Journal, X: 160-175, August, 1930. This article describes with illustrations the tabulation and analysis sheet for recording and anlyzing the results of an objective test. A sample test on magnetism and the test results are given. Instructional uses of the scheme are elaborated.—C. J. P.

Is the Department Headship in Secondary Schools a Professional Myth? HARLAN C. KOCH. School Review, XXXVIII: 336-349, May, 1930. An investigation of the activities or functions of 910 department heads in 171 high schools in 114 cities in 31 states shows that the major activities in which they participate are (1) effecting changes in curriculum of the department, (2) setting up budget, (3) keeping inventory of equipment and supplies, (4) selecting textbooks, (5) selecting teachers, (6) dismissing teachers, (7) promoting teachers.

The author concludes from his study that the department headship is in confusion, that there is little agreement among administrators as to what its function should be, that no generally accepted criteria of selection of individuals for the position are operative, and that superintendents and principals should either make the headship effectual or abandon it.—C. J. P.

SCIENCE EDUCATION IN GENERAL

Educational Values of Science Teaching. S. R. POWERS. Teachers College Record, XXXII: 17-33, October, 1930. "In a program of general education which is for the most part the program of the public schools, the work of instruction will be directed toward accomplishment of understanding of those principles and generalizations of science that have largest application to the work of the world. . . . In equally large measure the findings of science may have applications as factors influencing mental adjustments. Values which come from interpretation of natural phenomena may be even more far-reaching in importance in general training than many of those which come from understanding of applications." With this philosophy of the science curriculum, the author has set forth the "big ideas" of science as developed in treatises written by men of science for the general reader. Each of the big ideas is of such importance and so extensive in scope that, according to the author, "the student may live with them throughout his training period and throughout his life." The big ideas presented may therefore be considered the knowledge goals for the entire period of universal education. How these big ideas may be analyzed into their subordinate meanings is fully illustrated by the analysis of the present conception of the age

of the earth. Such analysis makes possible the selection of specific learning experiences at various grade levels and proposes a plan for the determination of the curriculum in science from the early grades to the college level. The analysis shows further how scientific thinking, scientific interests, and scientific attitudes may be developed as concomitants of the knowledge goals.—C. J. P.

An Experiment in Teaching. H. W. WHETZEL. Scientific Monthly, XXI: 151-162, August, 1930. With the assumption that much of the criticism leveled at the college student because of his disinterest in his scholastic work ought rather to be directed against the professors to teach them, Professor Whetzel reports the ten-year evolution of his present procedure in teaching a course in plant pathology at Cornell University. The plan outlined in some detail by the author consists in a series of projects with individual conferences. Advantages claimed for the plan over former teaching procedures are: each student can work at his own speed, time for real teaching is available, and each student has, at least, fifteen adequate opportunities during the term to exercise his mind in solving problems, arriving at conclusions, and making judgments on things in which he is presumably interested. The abstracter cannot refrain from calling particular attention to this article.—C. J. P.

A Study of Pupil Preferences. PAYNE TEMPLETON. School Review, XXXVIII, 532-537, September, 1930. Students in a western high school were asked to list their subjects in the order of their worth and also in the order of the time spent on them outside of class. After making note of a few of the variables in such procedure, the author gives the results in tabular form. Interestingly enough science and the social studies appear lowest in the list of worth or value to students. No marked relation between the value of the subject and the amount of time spent on it appears in the data.—C. J. P.

Instructional Material for the Small Laboratory. JOHN J. CONDON. School Science and Mathematics, XXX: 770-774, October, 1930. A discussion of the place of exhibits in teaching high school physics and chemistry. Posters, commercial exhibits, and projects of students were displayed. Many suggestions are given for carrying out this type of cooperative enterprise.—E. R. G.

Articulation of Natural Science Subjects in High School. L. PAUL MILLER. School Science and Mathematics, XXX: 783-767, October, 1930. A discussion of the duplication of textbooks and courses in high school science with suggestions for cooperative departmental work to obtain better coordination of general science, biology, chemistry, and physics.—E. R. G.

NATURE STUDY AND ELEMENTARY SCIENCE

Nature Study in the Los Angeles City Schools. W. L. NOURSE. School Science and Mathematics, XXX: 802-805, October, 1930. A brief account of science in the elementary schools of Los Angeles, as carried out by a director and seven asisstant supervisors in the 300 elementary schools of the city. An interesting description of the central offices, Library, and Museum is included. The annual general excursion of "seven miles" of pupils is described, as this trip is taken by all to Mt. Wilson.—E. R. G.

Science and Nature Study. School and Home, XIV: 1-62, March, 1930. The entire issue concerns Nature Study.—C. J. P.

Bibliography Suggested as Helpful in the Teaching of Nature Study. THEODOSIA HADLEY. Childhood Education, VI: 313-315, and 357-361, March-June, 1930.

GENERAL SCIENCE

General Science in the Junior High Schools of Los Angeles. W. L. NOURSE. School Science and Mathematics, XXX: 671-673, June, 1930. Fourteen criteria for a good textbook in ninth-grade science for a Los Angeles school are included in a brief general statement of the science instruction in the school.—C. J. P.

A Three-Year Course in General Science. HATTIE E. REICH. School Science and Mathematics, XXX: 653-658, June, 1930. General statements of the plan of the general science course in Springfield, Missouri, and a brief seasonal outline of the subject for seventh, eighth and ninth grades.—C. J. P.

The Development of Science in the Junior High Schools of Denver. HAZEL B. WATKINS. School Science and Mathematics, XXX: 618-625, June, 1930. A brief description of the development and present plan of revision of the well-known Junior High School Science Course.—C. J. P.

BIOLOGY

The Use of the Projection Microscope in the Teaching of Biology. N. HENRY BLOCK. School Science and Mathematics, XXX: 737-746, October, 1930. The feature of this article is a description of the projection microscope as used by Dr. F. P. Wimmer in the schools of Munich. Photographs are shown giving full details. The remainder of the article is devoted to projection apparatus available to American science teachers. Some excellent practical hints are included.—E. R. G.

A Standardized Test in Biology. J. L. COOPRIDER. School Science and Mathematics, XXX: 638-644, June, 1930. A summary of the stages in the formulation of the author's test and the average scores with standard deviations and probable errors on the revised test administered to 3,096 cases. There are also reported the inter-correlations of the various items of Cooprider's test as determined by Mayfield.—C. J. P.

PHYSICS

The Relation of Physics to the Textile Industry, and to the Measurement of the Physical Properties of Textile Fabrics. HERBERT J. BALL. School Science and Mathematics, XXX: 809-823, October, 1930. A discussion of the place of physics in the training of those who expect to work in the field of textile engineering. The practical applications of many branches of physics are shown,—such as the following: uniform linear motion, acceleration, harmonic motion, work, energy, mechanical efficiency, friction, parallelogram of forces and pendulum, as well as topics from heat, light and electricity. An article worthy of careful attention by physics teachers.—E. R. G.

A Lecture Demonstration of New Apparatus. P. E. KLOPSTEG. School Science and Mathematics, XXX: 546-562, May, 1930. Descriptions of seven new pieces of apparatus developed by Central Scientific Company.—C. J. P.

The Elements of Plane Geometry in High School Physics. H. M. ZERBE. School Science and Mathematics, XXX: 665-667, June, 1930. Ten different textbooks of physics and six laboratory manuals were examined to determine the theorems and constructions of geometry which the student of physics should know. A list of the theorems and constructions is given.—C. J. P.

CHEMISTRY

The Mathematics Used in Solving Problems in High School Chemistry. J. L. RENDAHL. School Science and Mathematics, XXX: 683-689, June, 1930. Another article on the much-discussed question of mathematics in science. Three textbooks of chemistry were analyzed. A list of mathematical terms found is given.—C. J. P.

Methods of Increasing Interest in High School Chemistry. ROBERT COLLIER, JR. Journal of Chemical Education, VII: 2141-2149, September, 1930. Factory exploration trips, the use of motion pictures, the chemistry party, the annual field trip, talks by chemists, the chemistry club, the American Chemical Society essay contest, and the use of exhibits are mentioned in the article.—C. J. P.

Training in Writing Chemical Equations. J. I. OSER. Journal of Chemical Education, VII: 2127-2130, September, 1930. Suggestions for aiding pupils over the major difficulties in writing equations and a short plea for postponing this phase of the work until pupils know some chemistry.—C. J. P.

Note-book Methods in High School Chemistry. HOYT C. GRAHAM. Journal of Chemical Education, VII: 1122-1124, May, 1930. A survey of note-book practices in 351 high schools throughout the United States: 93.2% require notebooks, 60.9% require loose-leaf notebooks, 61.7% do not use fill in blank form of notebook, 76.3% give grades on notebooks, and 56.7% have all notes written in laboratory.—C. J. P.

Salaries, Experience, and Training of Chemistry Teachers in Ohio High Schools. EARL W. PHELAN. Journal of Chemical Education, VII: 1928-1935, August, 1930. A survey of data secured from the principal's reports filed in the office of the state director of education. The following questions are answered: (1) In what schools are our teachers being prepared? (2) What training do they have? (3) What initial salaries do they receive? (4) What are the prospects for the future of a new teacher?—C. J. P.

Objectives of the Courses in General Chemistry. STUART R. BRINKLEY. Journal of Chemical Education, VII: 1869-1875, August, 1930. Four major objectives of a beginning course in college chemistry which seeks primarily not to train for future chemistry study but for life are elaborated following a brief review of various types of attempts to meet this new demand on chemistry.—C. J. P.

A Report of Freshman Chemistry Laboratory Administration. S. B. ARENSON. Journal of Chemical Education, VII: 1683-1687, July, 1930. A brief survey of the necessary equipment for freshman laboratory outfits, giving practices in fourteen large universities, a list of laboratory supplies required, and some valuable data on costs.—C. J. P.

A Chamber Sulfuric Acid Plant for Lecture Demonstration. W. C. OELKE. Journal of Chemical Education, VII: 1668-1670, July, 1930. A description with illustrations of an apparatus which resembles in form and arrangement the commercial sulfuric acid plant.—C. J. P.

Some Projects in Chemistry. C. H. STONE. Journal of Chemical Education, VII: 1656-1658, July, 1930. "With the thought of providing some experimental work in which the results of experiments would not be known in advance, certain projects were devised for use in our chemistry classes." Projects described include: obtaining barium chloride from witherite, preparing epsom salts from magnesite, preparing copper and chief copper salts from malachite ore, preparation of calcium chloride from marble dust, and 100 grams of lead nitrate from litharge or cerussite.—C. J. P.

New Books and Monographs

Matter and Energy—1930—Gerald Wendt and Oscar F. Smith—327 pages—P. Blakiston's Son and Co., Philadelphia.

This volume has as its purpose the relieving of students in taking lecture notes in an orientation course in physics and chemistry. The text represents such material used in the School of Liberal Arts and the School of Education in the Pennsylvania State College. According to the authors "it disregards the classical methods of introducing the subjects and, indeed, makes no pretense of being a course in either subject." Each chapter is meant to introduce the student to general or topical questions to be followed by instructors' experiments and class discussion. Important topics considered are: Things in General, Material Differences, Solidity and Dispersion, The Effect of Temperature, Transformations of Matter, Pressure in Chaos, Molecules in Motion, Energy in Waves, Electrons, Positive Rays, X-rays, Radium, Within the Atom, and The Foundations of Chemistry.

Teachers colleges and liberal arts colleges will find in this volume and in the second volume, to be published soon, an orientation course in science for the first year different from any other published course which has come to the attention of the reviewer. The text will challenge scientific thinking on the part of the student and will, if properly supplemented with experiments of a real problem type, lead to an appreciation of the nature and value of scientific attitudes toward the material world. The reviewer is not convinced, however, that it is necessary to devote so much of the first volume to what appears to be a preparation for considering real life problems in the field of science.—C. J. P.

The Unit Assignment—1929—E. E. Windes and others—115 pages—University of Virginia Record, Extension Series, Secondary Education in Virginia, Vol. XIII, No. 5.

This bulletin contains a discussion on the application of the "Unit" method as a means of individualizing instruction by enrichment in assignments as contrasted with uniform assignments in segregated pupil groups. One section of the monograph outlines the guidance sheets or assignments used in connection with the study of Fire and Oxygen by General Science pupils. Three levels of assignment are given.—C. J. P.

The Unit Method of Teaching—1930—E. E. Windes and others—127 pages—University of Virginia Record, Extension Series, Secondary Education in Virginia, Vol. XIV, No. 9.

The bulletin describes the unit plan of teaching in certain high schools of Virginia. The plan is an application of accepted principles governing the learning process. A general introduction on the nature of learning and teaching and on general procedures is followed by descriptions of specific procedures in English, mathematics, social studies, science and Latin. One unit in General Science and one in Biology are outlined.—C. J. P.

Problems in General Science—1930—George W. Hunter and Walter G. Whitman—688 pages—525 illustrations—American Book Company, New York.

This is a text-book in general science. The authors do not state for which grade the text is intended. Presumably it fits ninth grade pupils, since the term, general science, has been commonly accepted as the title of the science course for this grade.

The book is not a revision of *Civic Science in Home and Community* by the same authors. It is an entirely new book with a different

type of organization. The content is set up in the form of twenty-one major units each with several sub-divisions. These sub-divisions are each headed with titles in the form of problems stated as big questions. The general selection of content follows the rather standard pattern established by studies of the content of the general science course. The authors accept *A Synthesis and Evaluation of Subject-Matter Topics in General Science* by F. D. Curtis as the basic authority for selection of content.

Each large unit is set up according to the following type of organization: (1) preview; (2) problem statement; (3) text, including directions for demonstrations and practical exercises; (4) a self-testing exercise for pupils for each sub-problem; (5) a review summary; (6) a test of fundamental concepts; (7) an achievement test in the form of questions to be answered; (8) a set of practical problems, projects, reports, questions for debate and suggestions for the home laboratory; (9) a list of helpful references. An outstanding feature of the text is to be found in this elaborate extension of teaching devices and suggestive pupil activities.

Mechanically the book is attractive; the cover, the introductory illustrations in color, the text illustrations all make for appeal to the eye of teacher and pupils.

At the end is a glossary of important terms. Content is up-to-date in terms of treatment of modern applications of science; aviation, automobiles, radio, television, etc.

Too much material may be covered in a brief way. This is a common difficulty of general science texts and of the course as it exists in schools today. A single consistent thread of thought running completely through the whole text is difficult to find. This also is fairly common to most general science texts and courses.

The book is to be seriously considered as one of the important newcomers and should be examined by every general science teacher. —R. K. W.

Work Book in General Science—1927—Ellis C. Persing and Kimber M. Persing—127 pages—46 illustrations—Harter Publishing Company, Cleveland.

This is a work book and "self-directed study course" in general science. No statement concerning the grade placement of the material is made by the authors in the preface. The title, "general science," would indicate ninth grade but the simplicity of many of the exercises and some of the subject-matter might indicate seventh or eighth grade level.

The content is divided into sixteen large divisions. Each of these is subdivided into exercise units called problems. Under each of these problems are directions for work to be done. Notes, tabulations, drawings, summaries, etc., are to be placed in the book itself in spaces provided.

No basis for the selection of the major unit divisions and problems is indicated. The titles of the first two-thirds of the material follow closely the standard content indicated by recent investigations. Other units depart rather widely from the pattern of the present general science course. The units on plants and animals are largely of the nature study type.

References are very limited, chiefly to those of an encyclopedic type and a few of the older general science texts.

Illustrations are chiefly diagrammatic and of the kind that are of assistance to pupils in following directions.

There are no tests indicated other than the products of the pupil written into the book.

The problems and exercises would indicate a considerable number of laboratory exercises to be carried on by pupils. This type of

school material should be of assistance to teachers seeking to get away from recitation as a stereotyped teaching procedure. Exercises are so arranged that each individual pupil may progress at his own rate.—R. K. W.

A General Science Workbook—1930—Charles H. Lake, Louis E. Welton and James C. Adell—346 pages—120 illustrations—Silver, Burdett and Company, New York.

This is the second general science workbook to be developed in the Cleveland System. No statement is made concerning the grade in which it is intended that this book shall be used. From the title and the degree of difficulty of the material presented it is supposed that ninth grade is implied. The authors state that they have "attempted to prepare for the pupil who is just beginning the study of science a series of graduated problems" . . . and that "the material in this work book is suitable for use with any textbook in general science."

The content of the book is divided into sixteen major units. These were selected after a "thorough study of a wide range of topics covering the field of elementary science." Each major unit is divided into some six to twelve problems. Under each of the problems are to be found the directions for work. A considerable body of simple laboratory activity is provided. A large amount of the work consists of answering questions, the answers to which are to be written in spaces provided in the book. Considerable variation in work to meet individual needs is possible.

Each unit has a title which is phrased in the form of a problem question. At the beginning of each unit is a set of exploratory or overview questions. Just what is to be done with these is not quite clear. There follows a set of page and volume references to two popular encyclopedic reference works for children. The directions for work follow, divided among the sub-problems. At the end of each unit are found page references to some twelve to twenty general science texts, a long list of questions for study, and a vocabulary list.

The authors state that each unit is provided with objective tests. These are not included in the workbook.

Most of the illustrations are of the diagrammatic type and are used as aids to directions for work. A few are merely pictures of the common textbook type.

Many teachers will find this workbook useful. It is worth the examination of teachers looking for the kind of help offered by workbooks in other fields.—R. K. W.

Studying the Major Subjects—1930—C. C. Crawford—Published by the author, University of Southern California, Los Angeles.

This volume is a companion to *The Technique of Study* published by the author in 1928 and like the latter is intended as a textbook for courses in how to study, given to high school and college freshman students. Specific suggestions based upon a job analysis of students' difficulties are presented for studying each of eleven school subjects. Physics, chemistry and biology are included in these subjects. The suggestions on methods of study were collected from students and teachers and evaluated by the author. The book will serve teachers as a valuable aid in helping their students to realize the methods used in the study of a particular subject. The treatise must, of course, be quite general in scope considering the wide field covered.—C. J. P.

News Service Bulletin, School Edition, Nos. 3-56, Carnegie Institute of Washington, 1926-1929.

The Carnegie Institution of Washington began publishing in 1926 a series of News Service Bulletins for use in schools. The bulletins consider in simple language accompanied by excellent illustrations various science activities of the Institution. The edition of these bulletins is limited to 1000 copies and has been prepared to test the idea as to whether or not the bulletins have educational value. To this end 1000 schools have been placed on the mailing list for free service. The policy of future publication will be determined upon the basis of comments received from those using the bulletins. Sample copies of unbound current issues are available upon request.

These bulletins are of great service to the science and geography teachers and it is hoped that the Institution will decide to publish them in quantity for school use. The following titles chosen at random will give some idea of the nature of the bulletins: Exploring the Depths of Space, What Attracts Insects to Flowers, Gravity on the Earth and Moon, Pictures of the Past in Asphalt, The Measure of Man's Vital Energy, Birds as Heat Engines, The Carnegie's Cruise in the North Atlantic, Colonel and Mrs. Lindbergh Aid Archaeologists, and Further Light on the Structure of Matter.—C. J. P.

Crucibles: The Lives and Achievements of the Great Chemists—1930—Bernard Jaffe—472 pages—$5.00—Simon and Shuster.

Four years of painstaking study and work has resulted in a fascinating review of the milestones of progress in the field of chemical science. The author has been rewarded for his unusually well-written story by the satisfaction which must come upon the recognition which his volume has received in being selected from among several hundred manuscripts, submitted in competition for the Francis Bacon Award for the Humanizing of knowledge, as the most worthy piece of writing in a given branch of knowledge. The volume has also been selected as the June book of the month by the Scientific Book Club of New York City.

To indicate the scope of the book it is enough to mention the names of the alchemists and chemists whose personalities and contributions are revealed in truly brilliant fashion: Trevisan, Paracelsus, Becher, Priestley, Cavendish, Lavoisier, Dalton, Berzelius, Avogadro, Canuizarro, Woehler, Liebig, Mendeleeff, Arrhenius, Ostwald, van't Hoff, Curie, Thompson, Moseley and Langmuir. The contributions of scores of other scientists are woven into the stories of the work of these leaders.

It is perhaps worth noting for readers of this journal that the author of Crucibles is a teacher of high school chemistry. This fact has its significance in that his story is told in language simple enough for the high school pupil. An excellent bibliography of sources is included. The reviewer recommends the book to every high school science library.

It is this kind of writing which will not be the target of the literary critics and which will popularize science in a fully defensible way.—C. J. P.

Qualitative Analysis—C. J. Brockman, Associate Professor of Chemistry, University of Georgia—Ginn & Co., Boston, Mass.—1930—x + 197 pp.—Tables—15½ × 23 cm.—$2.20.

Must tradition be the law in qualitative analysis? Prof. Brockman says, "No!" Most of us were brought up—chemically—in an atmosphere of hydrogen sulphide, and to the amazement of outsiders were able to stand it. That Qualitative Analysis may be systematically practiced without this malodorous assistant is the effort of this text to establish.

In the preface, the author states, "In the development of this new

method of separating the metallic ions in which hydrogen sulphide is not used, it has been found that in the elementary course in qualitative analysis the student saves considerable time." Other alleged advantages of the proposed scheme are: no gaseous precipitation; success not dependent upon refined concentrations of reagents; precipitates are stable and do not change by standing in air; theoretical considerations such as solubility product and common ion effect are quite as thoroughly presented without involving hydrogen sulphide.

Since the present writer's task is to review the book and not to evaluate the technics, it may be frankly said that no trial of the proposed scheme has yet been made by our students. The idea, however, is very intriguing.

The book is divided into five parts with the following titles: Part I. General Principles; Part II. Reactions and Analysis of the Metals (Cations); Part III. Reactions and Analysis of the Acids (Anions); Part IV. Systematic Analysis of Solids and Liquids; Part V. Appendix. The introduction appears to be at the level of the college freshman, but is, nevertheless, a sound summary of the fundamental conceptions which now govern contemporary thinking on the subject of solution. There is nothing unorthodox in Part I. Likewise, Parts III, IV and V conform to the patterns of the best texts in vogue—thoroughly modern, yet systematically thorough within the limits the author sets for himself.

Part II deals with the separation and detection of the metals. It is to be regretted that these are narrowly limited to the 25 traditional ones without mention of Vanadium, Molybdenum, Tungsten, etc., with which actual practice is becoming concerned more and more. However, the proposed scheme of separation is worthy of consideration. The common metallic ions are divided, as usual, into six groups (but not the traditional ones). Groups I, II and IV are separated as precipitates; and II, V, and VI as solutions (filtrates). Briefly, the scheme is this:

Group I: Ag, Pb, Hg(ous) separated by HCl as Chlorides.

Group II: Ba, Sr, Ca, Pb separated as sulphates by H_2SO_4 and alc.

Group III: Sn, Al, Sb, Zn, Cr, As separated as components of the anions of Potassium salts by utilizing their amphoteric character, using KOH and Na_2O_2. The compounds K_2SnO_3, $KAlO_2$, $KSbO_3$, K_2ZnO_2, K_2CrO_4 and K_3AsO_4 are thus contained in the resulting solution.

Group IV: Mn, Fe, Bi, Mg separated as insoluble phosphates by successive treatment with aqua regia, ammonium carbonate, ammonium hydroxide and ammonium phosphate.

Group V: Cu, Hg, Co, Ni, Cd separated as complex ammonium salts in solution as the result of the previous group reagents.

Group VI: Na, K, NH_4 are tested for in the original sample or after removing groups I and II. Individual identification and confirmation are arrived at by methods in common use, albeit many of the more modern reagents such as formin, sulfanilic acid, uranyl acetate and others are recommended in place of the older methods.

Altogether, the text appeals to the spirit of non-conformity found in most of us and recommends itself to careful trial. In this day of research and progress in creative chemistry it is indeed surprising that so few efforts have been directed at improvement in the system of qualitative analysis. New methods for special separations, of course, appear constantly in our journals, but it does seem that even

the advent of the ionization theory and its application by Ostwald to analysis did not break down the traditional system. Professor Brockman deserves credit for his courage in attempting the innovation. Thorough trial alone will disclose the practicability of his proposals.

In its physical aspects—paper, print and binding the book is attractive; and the tables, summaries and organization of material, all combine to recommend it for either instructional or reference purposes.—R. E. HORTON.

Green Magic—1930—Julie Closson Kenly—194 pages—D. Appleton and Company, New York.

This book is intended to stimulate the interests of boys and girls in nature. It tells the story of the life history of plants, and discusses the important plant structures, such as leaf, stem, root, and fruit and the various habits which enable plants to live and reproduce in their environmental conditions. The author emphasizes in an elementary way some of the fundamental truths of science which will help the reader interpret phenomena in his commonplace environment. Throughout the story interesting activities are suggested, and at the close of the book are review questions covering points discussed in each chapter. The book is illustrated by wood cuts by Edna M. Reindel.

The story is made fanciful by attributing to plants characteristics, such as thinking, planning, and acting, which they obviously do not possess. Unfortunately some impressions given by the content, as well as the use of certain scientific terms, are not in harmony with those generally accepted in scientific literature.—FLORENCE BILLIG.

Nature Study, Book II—1930—John H. Gehrs—208 pages—American Book Company, New York.

This is the second book of a series written by Mr. Gehrs, Head of the Department of Agriculture, Southeast Missouri State Teachers College, Cape Girardeau, Missouri. In Book I, the author aims to stimulate the natural interests of boys and girls in the living things about them. Through these interests he hopes to guide children of elementary school age in acquiring a knowledge of the common plants and animals in the everyday environment.

A summary of the subject matter treated in Book II gives the following:

1. A general survey of the outstanding characteristics of mammals, birds, fishes, and insects.
2. A consideration of insects in their relation to disease, agriculture, and horticulture and their various services to man. Practical methods of control are emphasized.
3. A discussion of various structures and habits of common plants and animals which enable them to live and reproduce under their environmental conditions.
4. A discussion of plants that are of economic importance to man, such as cotton, flax, and various members of the grass and legume families.
5. A study of phases of physical nature, such as rocks, soil, weather, climate, and the solar system.

This book, which is illustrated by one colored plate and many photographs and drawings, is a general summary of information in various fields of science rather than a book that will stimulate the young reader to active thinking and doing. The well-selected subject-matter considered by the author makes it helpful as reference material for boys and girls between the ages of ten and fourteen years.—FLORENCE BILLIG.

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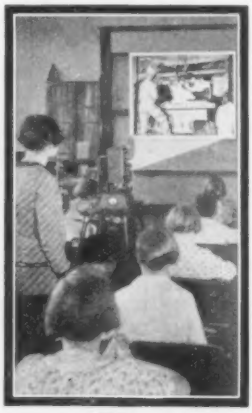

EASTMAN *CLASSROOM FILMS*

The Principles of Agronomy—1930—F. S. Harris and George Stewart—581 pages—129 illustrations—$2.00—The Macmillan Company.

This is a book of the high school level. It is a rewritten revision of an earlier work. The text is factual material. There are no pupil exercises or questions for stimulation of thought. These are the four main divisions: I. The Plant; II. The Soil; III. Field Crop; IV. Field Management.

Radio and Electric Power Supply Equipment for Schools—1930—E. H. Blom—188 pages—$2.00—Bureau of Publication, Teachers College, Columbia University.

This is a timely book because many schools are now facing the problems discussed here. Part I takes up "radio and allied equipment for schools." This includes the radio phonograph pick-up and public address systems. Part II takes up "electric power supply for high school science rooms." This includes power for lecture demonstration and laboratory for general science and for each of the special sciences. There is valuable information in the appendix on types of installations.

Dietetics and Nutrition—1930—Maud A. Perry—332 pages—$2.50—C. V. Mosby Company.

This book aims to present an elementary knowledge of the science of dietetics and human nutrition in simple language for schools, training schools for nurses and teachers. Among the thirty-two chapter titles we find these: "Food and the Normal Diet," "Nitrogenous Foods," "Non-nitrogenous Foods," "Vitamins," "Mineral Salts," "Care and Preservation of Foods," "Nutrition," "Metabolism," "Feeding the Sick," and "Diet for Different Diseases."

Natural Science Education in the German Elementary Schools—1930—Lois Meier—158 pages—$1.75—Bureau of Publication, Teachers College, Columbia University.

As science teachers in one city are interested to know what science teachers in other cities are doing, so there are many who would like to know what progress is being made in science teaching in other countries. This report gives an account of what the author was able to learn during more than a year of research and study in Germany. It takes up aims, methods, equipment, and organization of material for the eight grades of elementary school. It also devotes several chapters to the training of teachers for the elementary schools. A brief comparison with related problems in the United States helps to make this study of value to educators in general.

Fundamental Theory of Electrical Engineering—1930—Arthur L. Albert—223 pages—$3.20—Ginn Co.

This is a college text for the undergraduate student in beginning electrical engineering, and for use in industrial training courses. It covers elementary principles of mechanics, theories of electricity, units of electrical measurement, electrochemistry, electric power and energy, the dielectric circuit, the magnetic circuit, inductance, alternate current problems, and electrical measuring instruments.

Stars Through Magic Casements—1930—Julia Williamson—241 pages—illustrated—$2.00—D. Appleton and Company.

This is a collection of stories, legends and myths, which are told in a manner both to interest one in the stars and to kindle one's imagination about them. They are drawn from the ancient Greek and Roman, from the Japanese, and from American Indian sources. They will be eagerly read by grown-ups, as well as by children.

Personal and Community Health—1930—Clair E. Turner—443 pages—62 illustrations—$2.75—C. V. Mosby Company.

This text is for the use of students above the secondary school level. It provides the "subject-matter background for healthful living and citizenship and for health teaching at lower levels." Part One treats personal health and includes the hygiene of nutrition, mouth action, nervous system and reproduction. Part Two treats of community diseases, immunity, three plagues, food control, water supply, waste disposal, school and industrial hygiene, and ventilation.

Dietetics for High Schools—1930—Florence Willard and Lucy H. Gillette—290 pages—$1.40—Macmillan Company.

This text aims to present "the principles of nutrition in a clear and simple manner and to show the relation between these facts and the other health habits, so that they may be more easily applied in a general health program." The subject-matter includes: Our dependence on foods, energy value, energy requirements, importance of foods, mineral elements, vitamins, feeding the family, and marketing. There are forty-one tables and nine illustrations. There are several score cards, and each chapter closes with a short completion test.

Alternating Currents—1930—Calvin C. Bishop—317 pages—many diagrams—$2.00—D. Van Nostrand Co., Inc.

This is a text for technical, vocational, and engineering students who are familiar with direct electric current theory. It takes up fundamental topics: alternate currents; alternators; inductance; capacity; series and parallel circuits; vectors; transformers; asynchronous motors; synchronous motors and rotary converters; alternating current apparatus; practical tests for measurements; trigonometry useful in solving vector problems.

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An interesting diagram classifies the sciences and also shows their mutual dependence upon one another.

A Study of Biology Note-Book Work in New York State—1929—D. O. Baird—118 pages—$1.50—Bureau of Publication, Teachers College, Columbia University, N. Y. C.

This is a report of research covering the analysis and evaluation of biology laboratory note-books of students in the secondary schools of New York State. The main divisions of the report books are: the written units of work; study of the drawing, vocabulary and hand writing study; related factors—text, manuals and examination questions; the questionnaire study; summary and implications.

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